AD A 124137

INSTALLATION RESTORATION PROGRAM

PHASE I – RECORDS SEARCH

TINKER AFB, OKLAHOMA

ES ENGINEERING-SCIENCE

PREPARED FOR

UNITED STATES AIR FORCE
AFESC/DEV
Tyndall AFB, Florida

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-124 137	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Installation Restoration Program Phase 1: Records Search Tinker AFB, Oklahoma		5. TYPE OF REPORT & PERIOD COVERED Final 7/15/81 - 4/15/82
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Engineering-Science		8. CONTRACT OR GRANT NUMBER(s) F08637-80-G-0009 Call #0008
9. PERFORMING ORGANIZATION NAME AND ADDRESS Engineering-Science 57 Executive Park South, NE Suite 590, Atlanta, Georgia 30329		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (DEQPPM) 81-5
11. CONTROLLING OFFICE NAME AND ADDRESS HQ AFLC/DEPV Wright-Patterson AFB, OH 45433		12. REPORT DATE April 1982
		13. NUMBER OF PAGES 216
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) United States Air Force AFESC/DEV Tyndall AFB, Florida		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Resource Conservation and Recovery Act of 1976 and the Comprehensive Environmental Response, Compensation, and Liability Act created the requirement for the Air Force to assess the environmental quality of Air Force installations with regard to past use, storage treatment and disposal of toxic and hazardous materials and to define any conditions that may adversely affect health or result in environmental degradation. The USAF Installation Restoration Program (IRP) implements Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 DoD Installation Restoration Program. The extent of probable contamination at Air Force Installations is

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) determined by a detailed analysis of records, including a history of operations, the geological and hydrological conditions which may contribute to migration of pollutants, and a search of ecological files for evidence of environmental effects resulting from contamination. This is Phase I of the Installation Restoration Program. Engineering-Science of Atlanta, GA completed this Phase I Records Survey at Tinker Air Force Base November 16-20, 1981. The results of this investigation are contained in the subject report.

(1)

INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH
TINKER AFB, OKLAHOMA

Prepared For

United States Air Force
AFESC/DEV
Tyndall AFB, Florida

April, 1982

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By

ENGINEERING-SCIENCE
57 Executive Park South, NE
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Atlanta, Georgia 30329

This report has been prepared for the U.S. Air Force by Engineering-Science for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force or the Department of Defense.

ES ENGINEERING-SCIENCE

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9656

April 15, 1982

Mr. Bernard Lindenberg
AFESC/DEVP
Tyndall AFB, Florida 32403

Dear Mr. Lindenberg:

Enclosed is the Engineering-Science, Inc. (ES) final report entitled "Installation Restoration Program, Phase I Records Search, Tinker AFB, Oklahoma." This report has been prepared in accordance with the ES proposal dated July 15, 1981 and Air Force Contract Number F08637-80-G-0009 Call #0008.

Presented in this report are introductory background information on the Installation Restoration Program, a description of the Tinker AFB installation including past activities, mission and environmental setting, a review of industrial activities at Tinker AFB, an inventory of major solid and hazardous waste from past activities, a review of past and present waste handling, treatment and disposal facilities, an evaluation of the pollution potential of waste disposal sites, and recommendations for the Installation Restoration Program, Phase II, Problem Confirmation.

Any questions concerning this report should be refered to the Office of Public Affairs, Tinker Air Force Base, (405) 734-2026.

We appreciate the opportunity to work with you and the other Air Force personnel who contributed information to us for the completion of this assessment.

Very truly yours,

ENGINEERING-SCIENCE, INC.

E J Schroeder

E. J. Schroeder, P.E.
Manager, Solid & Hazardous Waste

EJS/lmr

Enclosure

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Department of Defense (DOD) has developed a program to identify and evaluate past hazardous material sites on DOD property, to control the migration of hazardous contaminants, and to control hazards to health or welfare that may result from these past disposal operations. This program is called the Installation Restoration Program (IRP). The IRP has four phases consisting of Phase I, Initial Assessment/Record Search; Phase II, Problem Confirmation; Phase III, Technology Base Development; and Phase IV, Operations. Engineering-Science (ES) was retained by the Air Force Engineering and Services Center to conduct the Phase I, Initial Assessment/Records Search at Tinker AFB under Contract No. F08637-80-G0009, Call No. 0008, using funding provided by the Air Force Logistics Command.

INSTALLATION DESCRIPTION

Tinker AFB is located in central Oklahoma southeast of Oklahoma City and contiguous with Midwest City. The base covers 4,277 acres and contains approximately 500 buildings. The base was activated in March 1942. The primary mission of the base is serving as a worldwide repair depot for several aircraft and a multitude of weapons and engines. This mission has remained unchanged since the late 1940's.

ENVIRONMENTAL SETTING

The environmental setting data reviewed for this study indicate the following key items concerning the impact of past waste disposal practices on the base:

- o Surficial soils at Tinker AFB are predominantly sands or silts which characteristically exhibit moderate to high permeabilities.
- o The primary regional aquifer, the Garber-Wellington, is present at or near ground-surface over most of the base area. Ground water is encountered within the aquifer at moderate depth (250

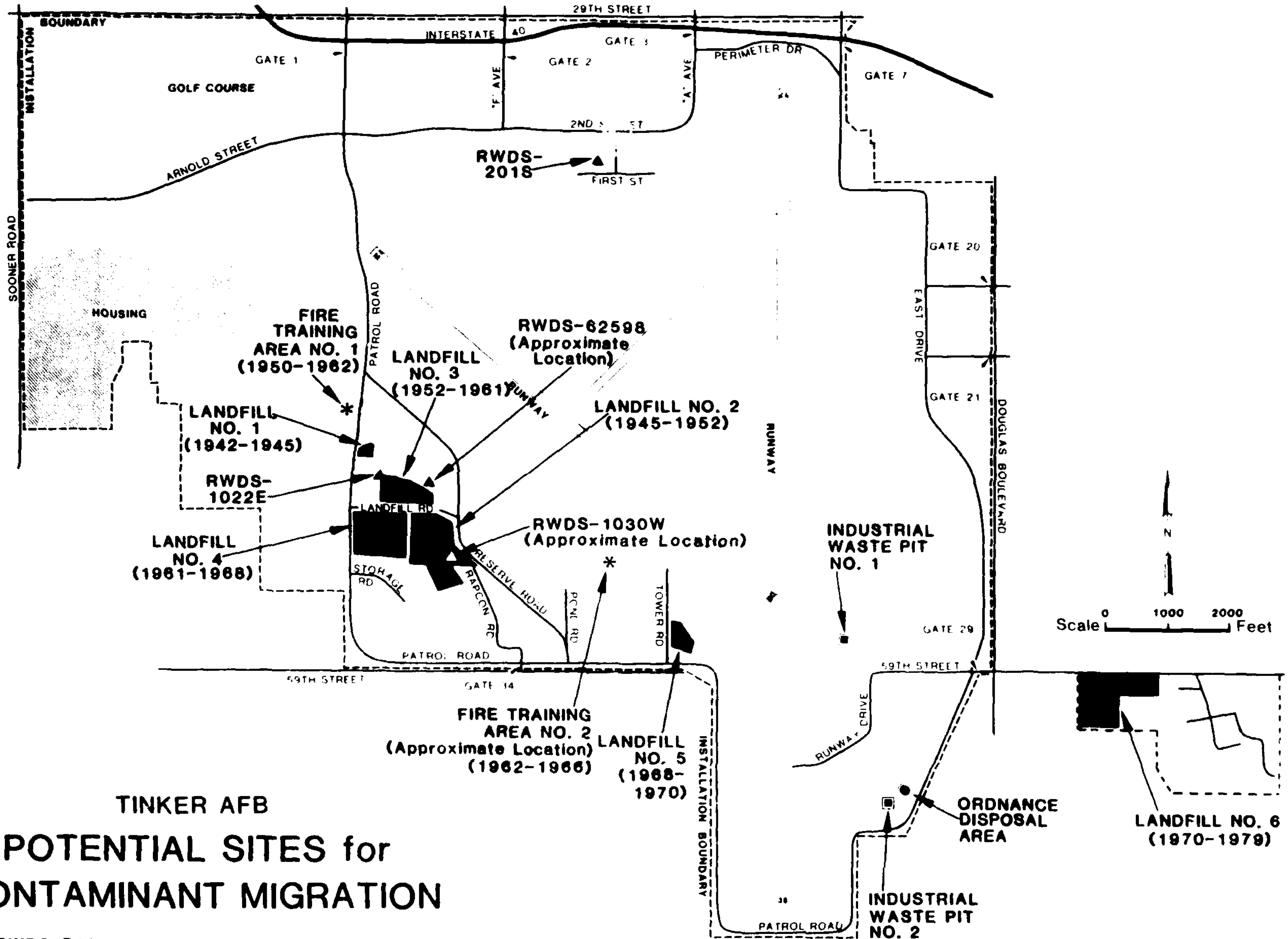
feet). The upper section of the aquifer is primarily an unsaturated zone.

- o Tinker AFB is located within a recharge area of the primary regional aquifer.
- o The historical contamination of base surface waters and associated sediments has been documented. Stream water percolation is known to be one form of recharge to the Garber-Wellington Aquifer.
- o The Tinker AFB mean annual precipitation is 32.4 inches, while lake evaporation is given at 60 inches as Tinker AFB is located in a water deficient zone of the U.S. Precipitation events releasing as much as 6.2 inches rainfall in a twenty-four hour period at Tinker AFB have been reported, causing local flooding (Weather Squadron Data).

METHODOLOGY

During the course of this project, interviews were conducted with base personnel (past and present) familiar with past waste disposal practices, file searches were performed for facilities which have generated, handled, transported, and disposed of waste materials, interviews were held with local, state and federal agencies, and site inspections were conducted at facilities that have generated, treated, stored, and disposed of hazardous waste. Fourteen disposal sites located on the Tinker AFB property were identified as containing hazardous waste resulting from past waste disposal activities (Figure 1). These sites have been assessed using a hazardous assessment rating methodology (HARM) which takes into account factors such as site characteristics, waste characteristics, potential for contaminant migration and waste management practices. The details of the rating procedure are presented in Appendix G and the results of the assessment are given in Table 1. The rating system is designed to indicate the relative need for follow-on action.

FIGURE 1



TINKER AFB

POTENTIAL SITES for CONTAMINANT MIGRATION

NOTE: RWDS-RADIOACTIVE WASTE DISPOSAL SITE

SOURCE: TINKER AFB DOCUMENTS

TABLE 1

PRIORITY RANKING OF POTENTIAL CONTAMINATION SOURCES

TINKER AFB

Rank	Site Name	Date of Operation or Occurrence	Overall Total Score
1	Landfill No. 4	1961-1968	70
2	Industrial Waste Pit No. 2	1958-1965	68
3	Landfill No. 2	1945-1952	65
4	Industrial Waste Pit No. 1	1947-1958	61
5	Landfill No. 3	1952-1961	60
6	RWDS 1030W	Prior to 1955	59
7	Landfill No. 6	1970-1979	56
8	Fire Training Area No. 1	1950-1962	55
9	Landfill No. 5	1968-1970	51
10	RWDS 1022E	Mid 1950's	49
11	Fire Training Area No. 2	1962-1966	47
12	Landfill No. 1	1942-1945	45
13	RWDS 62598	Early 1950's	37
14	RWDS 201S	Unknown	35

Note: This ranking was performed according to the Hazardous Assessment Rating Methodology (HARM) described in Appendix G. Individual site rating forms are in Appendix H.

FINDINGS AND CONCLUSIONS

The following conclusions have been developed based on the results of the project team's field inspection, review of base records and files and interviews with base personnel.

The areas determined to have a high potential for contaminant migration are as follows:

- o Landfill No. 4
- o Industrial Waste Pit No. 2
- o Landfill No. 2

The areas determined to have a moderate potential for contaminant migration are as follows:

- o Industrial Waste Pit No. 1
- o Landfill No. 3
- o RWDS 1030W
- o Landfill No. 6
- o Fire Training Area No. 1
- o Landfill No. 5

The areas determined to have a low potential for contaminant migration are as follows:

- o RWDS 1022E
- o Fire Training Area No. 2
- o Landfill No. 1
- o RWDS 62598
- o RWDS 201S

RECOMMENDATIONS

The detailed recommendations developed for further assessment of potential contaminant migration are presented in Chapter 6. These recommendations are summarized as follows:

- o Landfill No. 4 - Conduct geophysical survey and additional groundwater monitoring. Sample and analyze any leachate streams.

o Industrial Waste Pits No. 1 and No. 2	-	Obtain soil borings in and around the waste pits. Conduct geophysical survey to define site boundaries and identify any leachate plumes.
o Landfill No. 3, No. 5 and No. 6	-	Conduct geophysical survey and additional groundwater monitoring.
o Fire Training Area No. 1	-	Obtain soil borings in and around the fire training area. Conduct geophysical survey to define site boundaries and identify any leachate plumes.
o Base Streams	-	Conduct sediment sampling and additional water quality sampling on base streams. Measure stream water levels in conjunction with base monitoring wells to determine if the stream is the source of the shallow aquifer water.
o Water Supply Wells	-	Collect and analyze water samples from well Nos. 6, 7, 16, 18, 22, 23, 24, 25, 27 and 28.

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

BACKGROUND

The United States Air Force, due to its primary mission, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. Federal, state and local governments have developed strict regulations to require that disposers identify the locations and contents of disposal sites and take action to eliminate the hazards in an environmentally responsible manner. The Department of Defense (DOD) has issued Defense Environmental Quality Program Policy Memorandums 80-6 and 81-5 which require the identification and evaluation of past hazardous material disposal sites on DOD property, the control of migration of hazardous contaminants, and the control of hazards to health or welfare that resulted from these past operations. This program is called the Installation Restoration Program (IRP). The IRP will be a basis for response actions on Air Force Installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.

PURPOSE AND SCOPE OF THE ASSESSMENT

The Installation Restoration Program has been developed as a four-phased program as follows:

- Phase I - Initial Assessment/Records Search
- Phase II - Problem Confirmation
- Phase III - Technology Base Development
- Phase IV - Operations (Control Measures)

Engineering-Science (ES) was retained by the Air Force Engineering and Services Center to conduct the Phase I Records Search at Tinker AF Base under Contract No. F08637-80-G0009, Call No. 0008, using funding provided by the Air Force Logistics Command. This report contains a summary and an evaluation of the information collected during Phase I of the IRP.

The goal of the first phase of the program was to identify the potential for environmental contamination from past waste disposal practices at Tinker AFB, and to assess the potential for contaminant migration. The activities undertaken in Phase I included the following:

- Review site records
- Interview personnel familiar with past generation and disposal activities
- Inventory wastes
- Determine quantities and locations of current and past hazardous waste storage, treatment and disposal
- Define the environmental setting at the base
- Review past disposal practices and methods
- Conduct field inspection
- Gather pertinent information from federal, state and local agencies
- Assess potential for contaminant migration

In order to perform the on-site portion of the records search phase, ES assembled the following core team of professionals:

- E. J. Schroeder, Environmental Engineer and Project Manager, MSCE, 14 years of professional experience
- J. R. Absalon, Hydrogeologist, BS Geology, 8 years of professional experience
- D. G. Johnson, Environmental Engineer, MSCE, 4 years of professional experience
- M. I. Spiegel, Environmental Scientist, BS Environmental Science, 5 years of professional esperience
- R. M. Reynolds, Chemical Engineer, BSChE, 8 years of professional experience

More detailed information on these individuals is presented in Appendix A.

METHODOLOGY

The methodology utilized in the Tinker AFB Records Search began with a review of past and present industrial operations conducted at the base. Information was obtained from available records such as shop files and real property files, as well as interviews with past and present base employees from the various operating areas of the base. Those interviewed included current and past environmental personnel associated with the Civil Engineering Squadron, the Bioenvironmental Engineering Services Division office, and the Directorate of Maintenance. Several current or past personnel associated with the wastewater treatment plant, the pesticide operations, fuels management and the base solid waste disposal areas were interviewed extensively. Experienced personnel from the tenant organizations were also interviewed. Formal interviews were conducted with 71 individuals to obtain the needed past activity information.

Concurrent with the base interviews the applicable federal, state and local agencies were contacted and interviewed for pertinent base related environmental data. The agencies contacted are listed as follows:

- Oklahoma Geological Survey, Norman, Oklahoma
- U.S. Geological Survey, Water Resources Division, Oklahoma City, Oklahoma
- Oklahoma Water Resources Board, Oklahoma City, Oklahoma
- US Environmental Protection Agency, Region VI, Dallas, Texas
- University of Oklahoma Health Sciences Center, Department of Environmental Health, Oklahoma City, Oklahoma

The next step in the activity review was to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various operations on the base. Included in this part of the activities review was the identification of all known past disposal sites and any other possible sources of contamination such as fuel-saturated areas resulting from large fuel spills.

An aerial overflight and a general ground tour of identified sites were then made by the ES Project Team to gather site specific information including (1) visual evidence of environmental stress, (2) the presence of nearby drainage ditches or surface-water bodies, and (3) visual inspection of these water bodies for any obvious signs of contamination or leachate migration.

A decision was then made, based on all of the above information, whether a potential exists for hazardous material contamination at any of the identified sites using the decision tree shown in Figure 4.1. If no potential exists, the site was deleted from further consideration. For those sites where a potential for contamination was identified, a determination of the potential for migration of the contamination was made by considering site-specific conditions. If the potential for contaminant migration was considered significant, then the site was evaluated and prioritized using the hazardous assessment rating methodology (HARM).

The HARM score indicates the relative potential for contaminant migration at each site. For those sites showing a high potential, recommendations are made to quantify the potential contaminant migration problem under Phase II of the Installation Restoration Program. For those sites showing a moderate potential, a limited Phase II program may be recommended to confirm that a contaminant migration problem does or does not exist. For those sites showing a low potential, no further follow-up Phase II work would be recommended.

CHAPTER 2

INSTALLATION DESCRIPTION

CHAPTER 2

INSTALLATION DESCRIPTION

LOCATION, SIZE AND BOUNDARIES

Tinker AFB is located approximately in the center of the State of Oklahoma and contiguous with Oklahoma City (Figures 2.1, 2.2 and 2.3). The Base is within the North Canadian River drainage basin and drains principally into Crutcho and Soldier Creeks. The boundaries of the base cover 4,277 acres and contain approximately 500 buildings with 9.4 million square feet of floor space dedicated to operational, industrial, administrative and ordnance functions. Present land areas adjacent to the base are primarily as follows:

North - residential and commercial;
West - residential
South - residential, commercial and agricultural
East - residential, commercial and agricultural

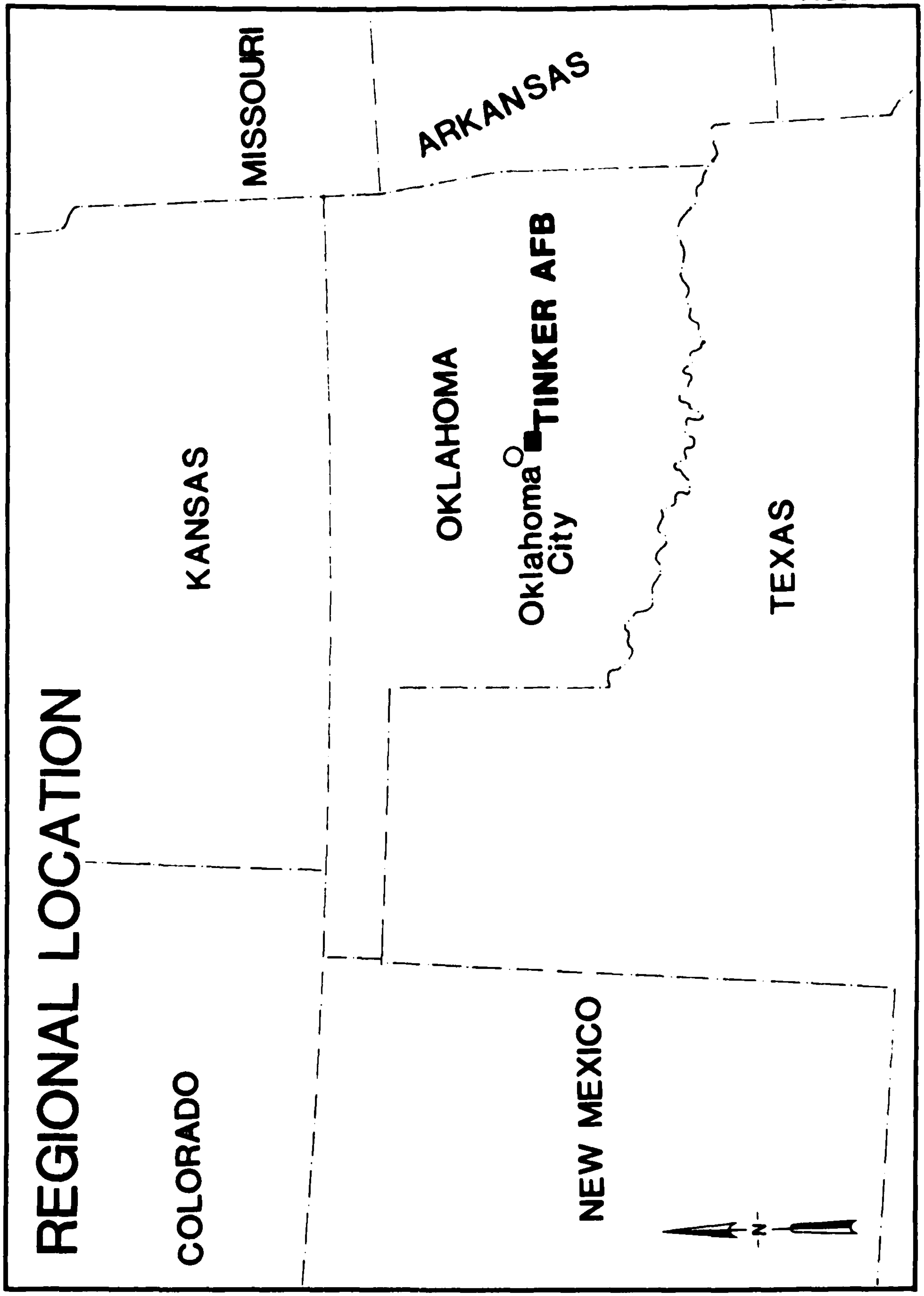
The most prominent physiographic feature of the area is the North Canadian River.

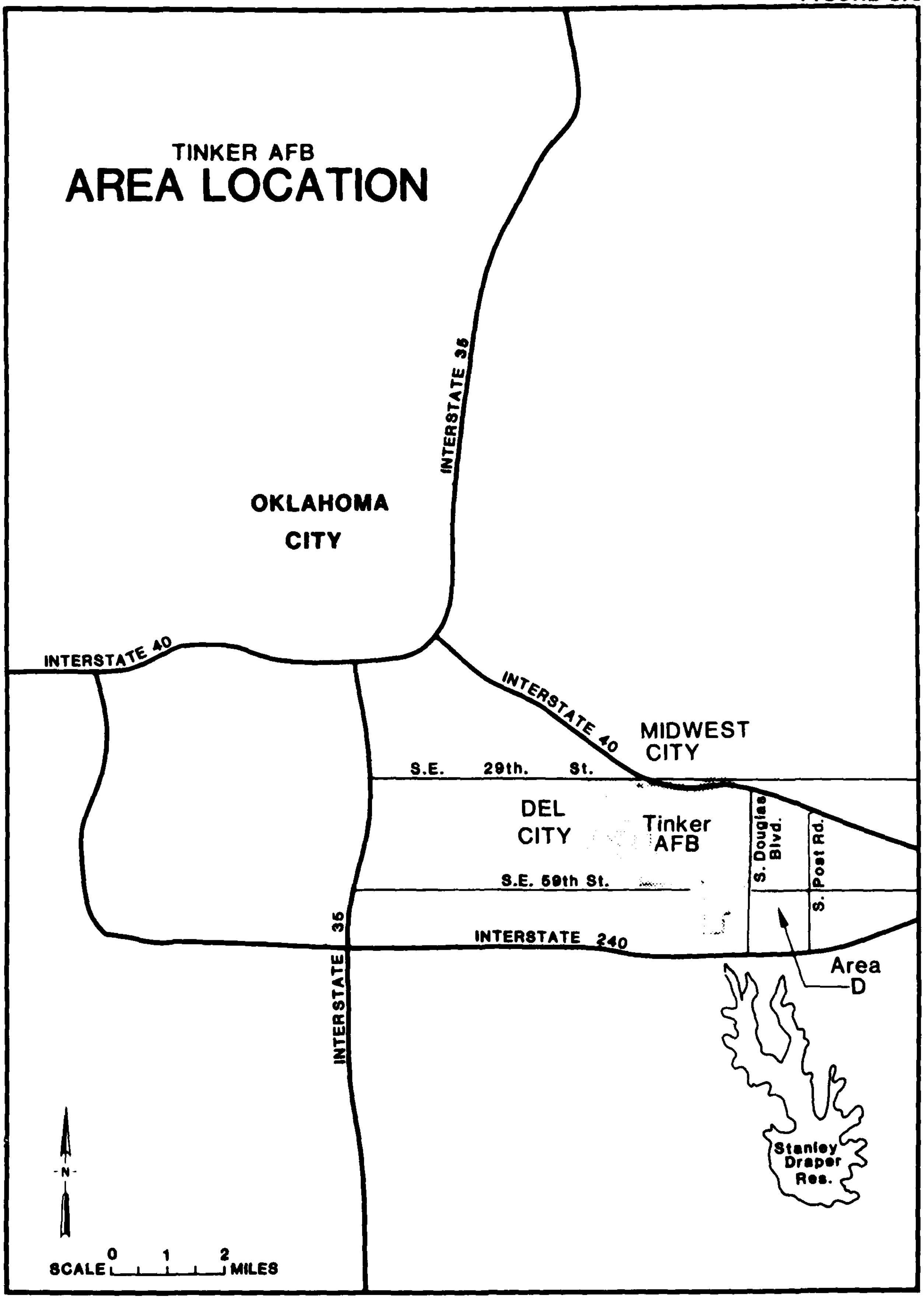
BASE HISTORY

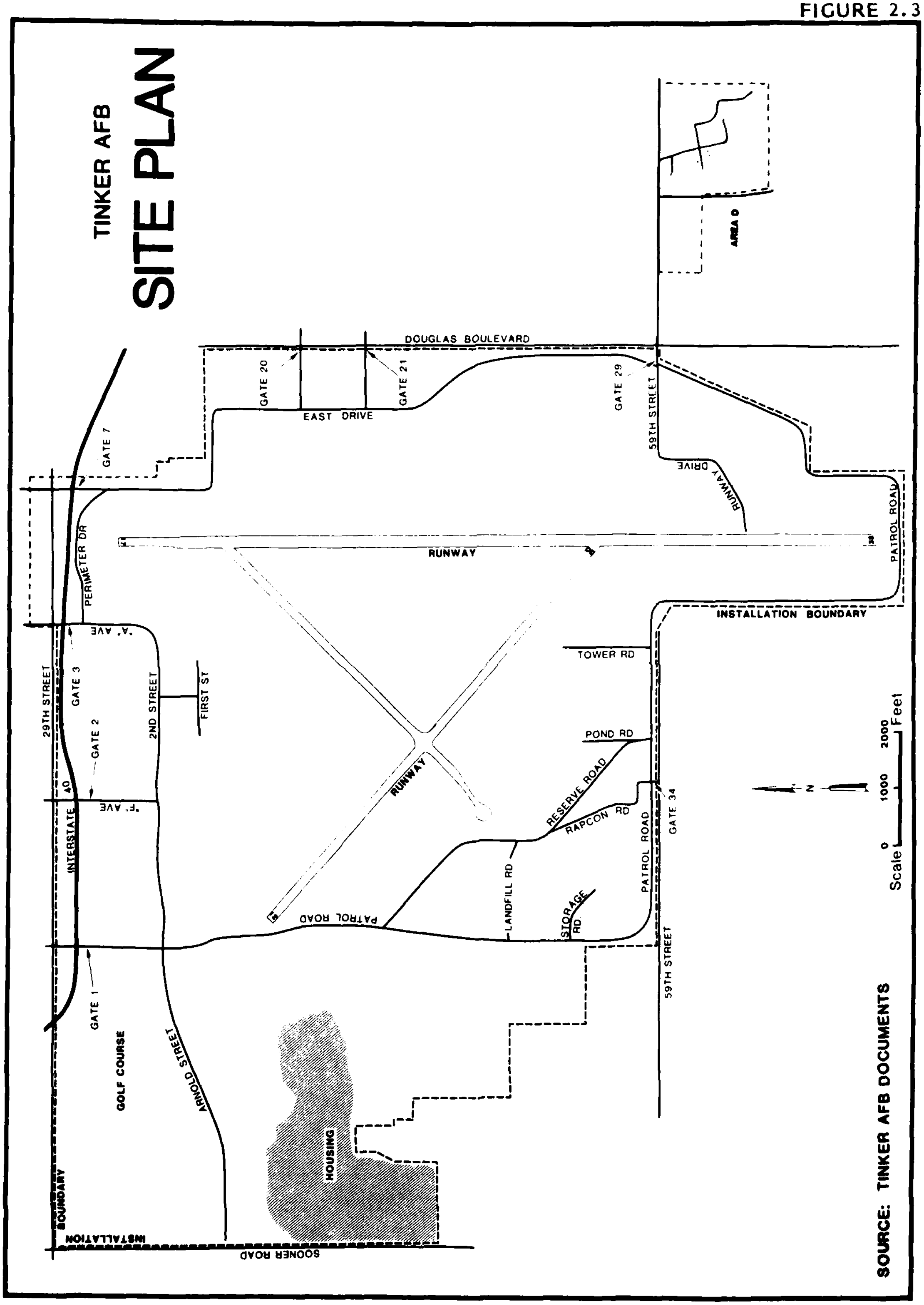
The initial construction of Midwest Air Depot (what is now Tinker AFB) began in July 1941, and the base was activated in March 1942. During World War II, the depot was responsible for reconditioning, modifying and modernizing aircraft, vehicles and equipment and the civilian employment peaked at 14,925 employees.

At the conclusion of World War II, the Douglas Aircraft Plant located east of the north-south runway was combined with the Base. Tinker became involved in jet engine overhaul and later modification of aircraft out of storage in a program to rebuild the nation's airpower. In 1948 Tinker Air Force Base became a worldwide repair depot for several aircraft and a multitude of other weapons and engines. The level of activity has fluctuated during history of the base, however the primary mission has

FIGURE 2.1


REGIONAL LOCATION
MISSOURI
ARKANSAS
KANSAS
OKLAHOMA
TINKER AFB
Oklahoma City
TEXAS
COLORADO
NEW MEXICO
N


TINKER AFB
AREA LOCATION
OKLAHOMA
CITY
INTERSTATE 35
INTERSTATE 40
INTERSTATE 40
MIDWEST
CITY
S.E. 29th. St.
DEL
CITY
Tinker
AFB
S. Douglas
Blvd.
S. Post Rd.
S.E. 59th St.
INTERSTATE 35
INTERSTATE 240
Area
D
Stanley
Draper
Res.
N
SCALE 0 1 2 MILES


TINKER AFB
SITE PLAN
DOUGLAS BOULEVARD
GATE 20
GATE 21
EAST DRIVE
GATE 29
59TH STREET
AREA D
GATE 7
PERIMETER DR
RUNWAY
RUNWAY DRIVE
PATROL ROAD
INSTALLATION BOUNDARY
'A' AVE
GATE 3
29TH STREET
2ND STREET
FIRST ST
TOWER RD
POND RD
RESERVE ROAD
RAPCON RD
GATE 34
GATE 2
INTERSTATE 40
'F' AVE
RUNWAY
LANDFILL RD
STORAGE RD
PATROL ROAD
GATE 1
GOLF COURSE
ARNOLD STREET
HOUSING
INSTALLATION BOUNDARY
SOONER ROAD
59TH STREET
N
Scale 0 1000 2000 Feet
SOURCE: TINKER AFB DOCUMENTS

not changed and Tinker AFB is still a major industrial complex for overhauling, modifying, and repairing military aircraft, aircraft engines, and accessory items.

The base has made several land acquisitions besides the Douglas Aircraft Plant. During 1951 the Air Force acquired a parcel of land located one half mile east of the southeast corner of Tinker AFB (Area "D"). The area was named the Oklahoma City Air Force Station and was supported by Tinker AFB. In 1956, the area officially became a separate entity; however support was still provided by Tinker AFB. The area was initially occupied by the 33rd Air Division and is presently occupied by the Engineering Installations Center, part of the Air Force Communications Command. In 1954 the base acquired a parcel of land south of the 59th Street boundary to extend the existing main runway. The land acquisition consisted of approximately 300 acres. During 1956, the base acquired additional land in the same area completing the parcel of land south of 59th Street presently within Tinker AFB jurisdiction. In 1957, a 638 acre tract of land immediately west of the original air base was acquired to develop permanent military housing and community support facilities. In 1975 the base acquired an additional 187 acres of land situated contiguous to the westside of Air Depot Boulevard between SE 59th Street and SE 44th Street.

A complete history of Tinker Air Force Base is presented in Appendix B.

ORGANIZATION AND MISSION

Tinker AFB has a multi-fold flying mission consisting of logistics support, administrative flight and pilot proficiency training. Production flight checks of aircraft that have undergone depot maintenance, repair and/or modification comprises the major portion of the logistic support flight mission. The 552nd Airborne Warning and Control Group (AWACW) operates and maintains the E-3A Sentry aircraft. The 552nd's mission includes training flights as well as support of the Tactical Air Commands worldwide mobile strike force. The Det 507, 301 Tactical Fighter Group (Reserves) performs tactical fighter training in the F-4 aircraft. The reserve unit maintains combat proficiency and readiness of the personnel and aircraft.

The support function for the base is performed by the 2854th Air Base Wing which contains all administrative, security, maintenance, housekeeping, housing, fire protection, legal assistance and logistical support for the base.

The Oklahoma City Air Logistics Center (OCALC) is the major organization at Tinker AFB. The mission of the OCALC is to provide logistic support to the operating commands of the USAF. The OCALC is the logistic support manager for almost all of the Strategic Air Command's bomber and tanker fleet, three air-launched missiles, a substantial portion of the jet engines in the Air Force inventory, and approximately 140,000 items in the hydraulics, pneumatics and instrument areas. The Center also supports a huge industrial complex to overhaul, modify and repair the aircraft, aircraft engines and a vast number of accessory items.

A description of the tenants and their missions is presented in Appendix B. The tenants of the 2854th Air Base Group include the following units:

- 552 Airborne Warning and Control Group (AWACG)
- Engineering and Installation Center
- Det 507, 301 Tactical Fighter Group
- 3rd Combat Communications Group
- Communications Computer Programming Center
- 6th Weather Squadron Mobile
- Air Force Audit Agency Office
- Defense Logistics Agency, Memphis Region
- Defense Property Disposal Office, Oklahoma City
- USAF Hospital, Tinker
- 2953rd Combat Logistics Support Squadron
- Det, 3025 AFLC Mgt Engr Team
- 1985th Communications Squadron
- AF Office of Special Investigation
- Corps of Engineers, Resident Engineer
- Dept of Transp, Federal Aviation Administration
- Det 1, 60th Military Airlift Wing
- Det 1, 17th Weather Squadron
- Det 15, 1365th Audio Visual Squadron
- Military Air Traffic Coord. Office

- General Services Administration
- U.S. General Accounting Office
- 403rd Combat Logistics Support Squadron (Reserves)
- OLCA 2400 Reserve Readiness and Mobile Squadron
- 72nd Aerial Port Squadron (Reserves)

CHAPTER 3

ENVIRONMENTAL SETTING

CHAPTER 3

ENVIRONMENTAL SETTING

The environmental setting of Tinker Air Force Base is described in this section with the primary emphasis directed toward identifying features that affect the movement of hazardous waste contaminants. A summary of the environmental setting pertinent to this study is presented at the end of the section.

METEOROLOGY

Temperature, precipitation and other relevant data furnished by Detachment 1, 17th Weather Squadron, Tinker AFB is presented in Table 3.1. The indicated period of record is 30 years. The summarized data indicate that mean annual precipitation is 32.4 inches and that mean annual snowfall is eleven inches. According to the Climatic Atlas of the United States, annual lake evaporation for the Oklahoma City area is estimated to be 60 inches.

GEOGRAPHY

The Oklahoma City area is located within the Central Redbed Plains section of the Central Lowland Physiographic Province (Curtis and Ham, 1972). The area is characterized by nearly level to gently rolling hills, broad flat plains and well-entrenched main streams. The valleys of secondary streams may exhibit a sag and swale appearance, indicative of the erosion of somewhat cohesive residual soils.

Topography

The topography of Oklahoma City and surrounding area varies from generally level to gently rolling in appearance. Local relief is primarily the result of dissection by erosional activity or stream channel development. At Oklahoma City, surface elevations are typically in the range of 1,070 to 1,400 feet MSL. At Tinker Air Force Base ground surface elevations vary from 1,210 feet MSL at the point where the east branch of Crutcho Creek intersects the base boundary to approximately 1,320 feet MSL at Area D, located on 59th Street, east of the main installation.

Drainage

Drainage of Tinker Air Force Base land areas is accomplished by overland flow of runoff to diversion structures and thence to area surface streams, which flow intermittently. The northeast portion of the base is drained primarily by Soldier Creek, a tributary of Crutcho Creek. The north and west sections of the base including the main instrument runway, drain to Crutcho Creek, a tributary of the North Canadian River. Two small unnamed intermittent streams crossing installation boundaries south of the main instrument runway generally do not receive significant quantities of base runoff due to site grading designed to preclude such drainage. These streams, when flowing, extend to Stanley Draper Lake, approximately one half mile south of the base. Installation drainage and the flow directions of surface streams are depicted on Figure 3.1.

Surface Soils

The surface soils of Tinker Air Force Base have been studied by the USDA, Soil Conservation Service (1969) and by several soil boring projects conducted for geotechnical (foundation construction) investigations. Three major soil associations have been mapped within installation limits and are depicted on Figure 3.2. The individual soil types are summarized on Table 3.2. The surface soils of the installation area are predominantly of two basic types: residual and alluvial. The residual soils associations, Darrell-Stephenville and Renfrow-Vernon-Bethany are the product of the weathering of underlying bedrock. The alluvial materials are stream-deposited silts and sands, whose occurrence is typically restricted to the floodplains of area streams.

GEOLOGY

The geology of the Oklahoma City area has been reported by Miser et al. (1954), Bingham and Moore (1975), Johnson and Luza (1980), among others. A brief review of the published information has been summarized in support of this investigation.

TABLE 3.1

SUMMARY OF
WEATHER DATA AT TINKER AFB, OK

MONTH	TEMPERATURE (°F)					PRECIPITATION (IN)				SNOWFALL (IN)			SURFACE WINDS	
	MEAN			EXTREME		MONTHLY				MONTHLY				
	DAILY MAX	DAILY MIN	MONTHLY	MAX	MIN	MEAN	MAX	MIN	MAX 24 HRS	MEAN	MAX	MAX 24 HRS	PREVAILING DIRECTION (16 PT)	MEAN SPEED (KT)
JAN	47	28	37	80	-7	1.2	6.1	#	2.2	4	25	6	S	11
FEB	52	32	42	85	-1	1.3	2.8	#	1.7	2	8	5	S	11
MAR	59	38	49	90	-1	2.0	5.2	.1	1.8	2	18	9	S	13
APR	71	51	61	94	25	3.3	8.7	.7	2.9	#	1	1	S	13
MAY	78	59	69	98	35	5.6	11.4	.3	5.7	0	0	0	S	11
JUN	87	68	78	105	52	4.2	13.5	.4	5.1	0	0	0	S	12
JUL	92	72	82	107	53	3.3	8.2	.1	3.7	0	0	0	S	10
AUG	92	71	82	107	56	2.4	9.3	#	2.8	0	0	0	S	10
SEP	84	64	74	107	40	3.5	11.3	#	6.2	0	0	0	S	10
OCT	74	53	64	98	26	2.5	7.5	#	2.7	#	#	#	S	10
NOV	60	40	50	83	11	1.6	7.3	0	2.0	1	6	2	S	11
DEC	50	31	41	85	0	1.5	3.5	#	2.3	2	11	6	S	11
ANN	71	50	61	107	-7	32.4	13.5	.0	6.2	11	25	9	S	11

Base Elevation: 1,291 feet
Period of Record: 1942-1972
#: trace amount

SOURCE: Detachment 1, 17th Weather Squadron

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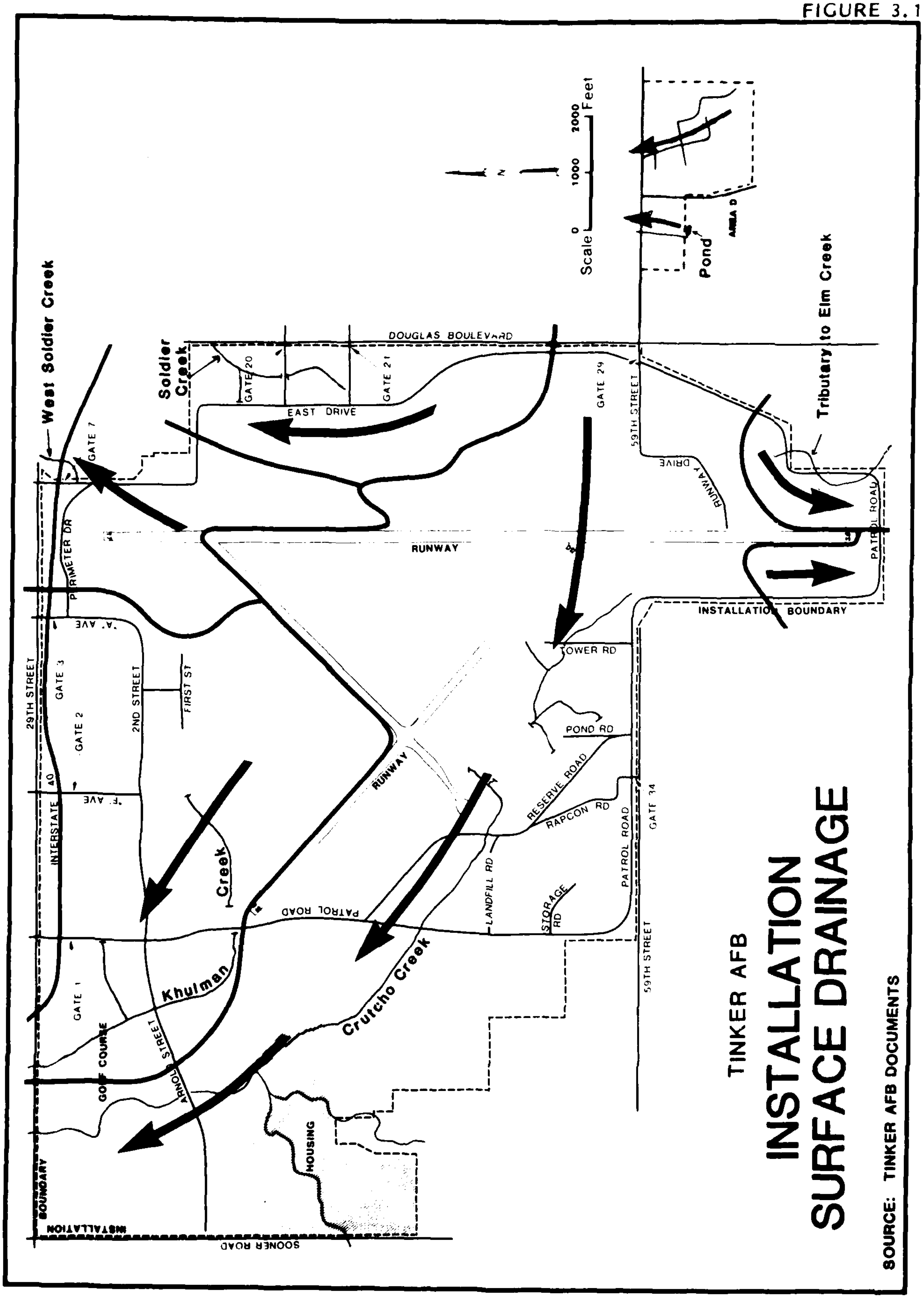


TINKER AFB
INSTALLATION SURFACE DRAINAGE
SOURCE: TINKER AFB DOCUMENTS

FIGURE 3.2

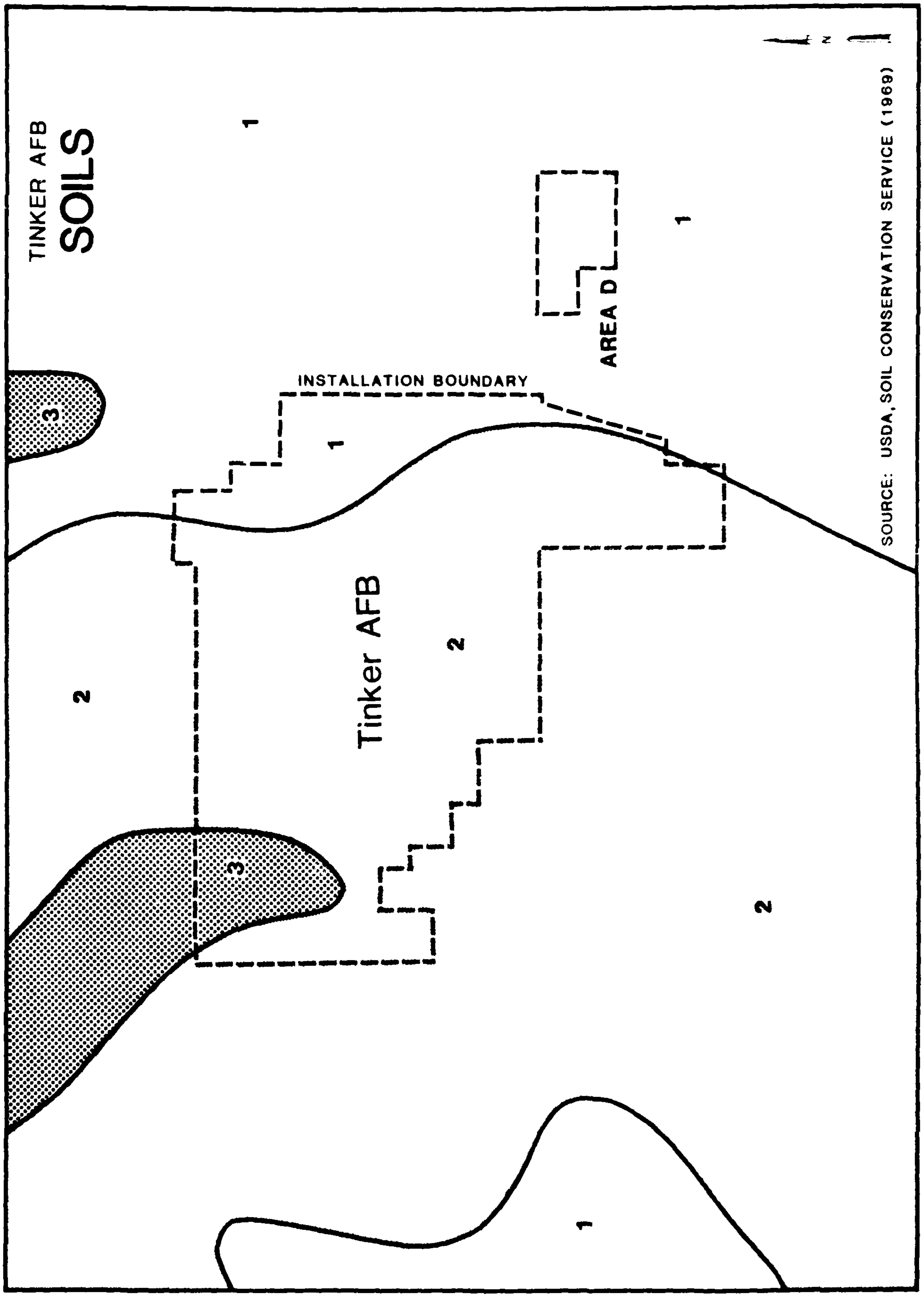

TINKER AFB
SOILS
N
1
1
AREA D
INSTALLATION BOUNDARY
1
3
Tinker AFB
2
2
3
2
1
SOURCE: USDA, SOIL CONSERVATION SERVICE (1969)

TABLE 3.2

TINKER AIR FORCE BASE SOIL ASSOCIATIONS

Symbol	Name	Description	Thickness in.	Unified Class.	Permeability in/hr*
1	Darrell-Stephenville: loamy soils of wooded uplands.	Sandy loam. Sandy clay loam. Soft sandstone. (Garber Sandstone)	12 - 54	SM, ML, SC	2.0 - 6.30
2	Renfrow-Vernon-Bethany: loamy and clayey soils on prairie uplands.	Silt loam - clay. Clay loam. Shale. (Fairmont Shale)	12 - 60	ML, CL MH, CH	<0.06 - 0.20
3	Dale-Canadian-Port: loamy soils on low benches near large streams.	Fine sandy loam. Silty clay loam. Loam. Clay loam	12 - 60	SM, ML CL	0.05 - 6.30

Source: USDA, SCS (1969).

* Although this characteristic of base soils is called "Permeability" by the Soil Conservation Service, it is actually a description of infiltration rates - the speed that water moves through unsaturated earth materials.

Stratigraphy

Geologic units ranging in age from Permian to Quaternary have been described in the Oklahoma County area and are summarized as Table 3.3. The lithologies of these units include unconsolidated deposits and sedimentary rocks.

Distribution

The physical distribution of significant geologic units relevant to this study are mapped as Figure 3.3, which has been modified from the work of Bingham and Moore (1975). Tinker Air Force Base geologic units are summarized on Table 3.4. Generally, the surficial geology of the north section of the installation is dominated by the Garber Sandstone, which crops out across a broad area of Oklahoma County. Weathering of the Garber has probably produced Darrell-Stephenville soils. The south portion of the base's surficial geology is reportly dominated by the Kingman Siltstone and the Fairmont Shale (as indicated on geologic maps by Miser (1959) and Bingham & Moore (1975). An inspection of the base and a review of available drilling information has failed to confirm the presence of the siltstone unit on base. Drilling information obtained as a result of geotechnical investigations and monitoring well installation does indicate the presence of the Fairmont Shale separating surface soils from the underlying Garber Sandstone. At some locations, however, the shale appears to be thin and/or discontinuous. In other base areas, the shale is absent as shown on Figure 3.3. The stratigraphic relationships of major geologic units present on base are presented on Figures 3.4 and 3.5, the logs of base monitoring wells.

Structure

Tinker Air Force Base lies within a tectonically stable area. No major faults or fracture zones have been mapped near the base. Most of the consolidated rock units of the Oklahoma City area are nearly flat-lying. The reported regional dip is forty feet per mile in a generally westward direction (Bingham and Moore, 1975).

HYDROLOGY

Ground-water hydrology of the Tinker Air Force Base - Oklahoma City area has been reported by Jacobsen and Reed (1949), Wood and Burton (1968), Bingham and Moore (1975), Bedinger and Sniegocki (1976) and

TABLE 3.3

MAJOR GEOLOGIC UNITS OF OKLAHOMA COUNTY

System	Series	Stratigraphic Unit	Thickness (feet)	Description and Distribution	Water-bearing Properties
QUATERNARY	RECENT	Dune sand	0-20	Fine-to coarse-grained wind-blown sand. Consists chiefly of subrounded quartz grains. Forms a thin mantle or hummocky surface that obscures older rocks. Most extensive deposits on north side of North Canadian River near Lake Overholser.	Moderately to highly permeable, but mostly above the water table and saturated only locally. Where saturated, yields water readily to domestic or stock wells, but supply may not be permanent. Water most likely to occur in this unit where underlain by poorly permeable redbeds. Provides infiltration areas for recharge to underlying rocks.
	PLEISTOCENE AND RECENT	Alluvium	0-70	Unconsolidated and interfingering lenses of sand, silt, clay, and gravel in the flood plains and channels of streams.	Moderately permeable. Yields small to moderate quantities of water to wells in valleys of larger streams. Water is very hard, but suitable for most uses, unless contaminated by industrial wastes or oil-field brines.
		Terrace deposits	0-100	Unconsolidated and interfingering lenses of sand, silt, gravel, and clay that occur at one or more levels above the flood plains of the principal streams.	Moderately permeable. Locally above the water table and not saturated. Where deposits have sufficient saturated thickness, they are capable of yielding moderate quantities of water to wells. Water is moderately hard to very hard, but less mineralized than water in other aquifers. Suitable for most uses unless contaminated by oil field brines.
PERMIAN	LOWER PERMIAN	Chickasha Formation and Duncan Sandstone	200 +	Beds of reddish-brown sandstone, siltstone, shale, and siltstone conglomerate. Individual beds of sandstone highly cross-bedded and well cemented, in western part of area between Canadian and North Canadian Rivers.	Poorly permeable. Tapped by only a few small-capacity wells for domestic or stock use. Water is hard and in places highly mineralized.
		Hennessey Group (Includes Kingman Siltstone and Fairmont Shale)	700	Deep-red clay shale containing thin beds of red sandstone and white or greenish bands of sandy or limy shale. Forms relatively flat to gently rolling grass-covered prairies.	Poorly permeable. Yields meager quantities of very hard, moderately to highly mineralized water to shallow domestic and stock wells. In places water contains large amounts of sulfate.
		Garber Sandstone	500 +	Deep-red to reddish-orange, massive and cross-bedded fine-grained sandstone interbedded with and interfingered with red shale and siltstone.	Poorly to moderately permeable. Important source of ground water in Cleveland and Oklahoma Counties. Yields small to moderate quantities of water to deep wells; heavily pumped for industrial and municipal uses in the Norman and Midwest City areas. Water from shallow wells hard to very hard; water from deep wells moderately hard to soft. Lower part contains water too salty for domestic and most industrial uses.
		Wellington Formation	500 +	Deep-red to reddish-orange massive and cross-bedded fine-grained sandstone irregularly interbedded with red, purple, maroon, and gray shale. Base of formation not exposed in the area.	

Source: Modified from Wood and Burton, 1968

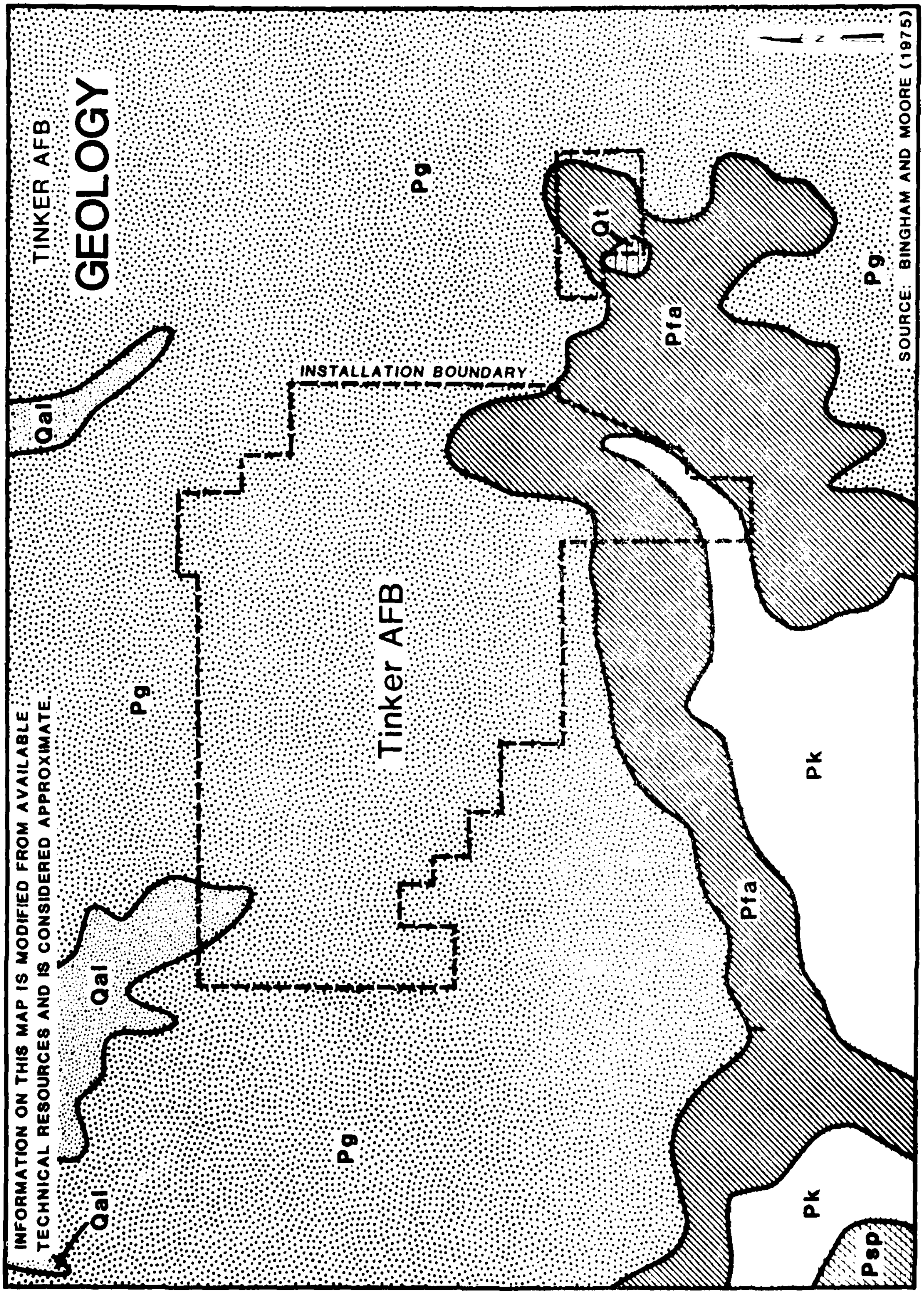

TINKER AFB
GEOLOGY
INFORMATION ON THIS MAP IS MODIFIED FROM AVAILABLE TECHNICAL RESOURCES AND IS CONSIDERED APPROXIMATE.
Tinker AFB
INSTALLATION BOUNDARY
Qal
Qal
Qal
Pg
Pg
Pg
Pg
Pfa
Pfa
Qt
Pk
Pk
Psp
N
SOURCE: BINGHAM AND MOORE (1975)

TABLE 3.4

TINKER AIR FORCE BASE GEOLOGIC UNITS (PERMIAN)

Map Symbol	Unit	Lithology	Thickness, ft.	Structure	Geomorphic Features	Remarks
Qal	Alluvium	Sand, silt, clay, gravel	5-100	varies	Floodplains, low areas near streams	Local aquifer
Qt	Terrace Deposits	Sand, silt, clay, gravel	10-100	varies	Upland areas, benches near streams	Local aquifer
Pk	Kingman	Even-bedded siltstones; some sandstone and shale	30	flat-lying	Gently rolling plains	Aquitard
Pfa	Fairmont	Blocky shale; thin sandstone interbeds	30	flat-lying	Gently rolling plains	Aquitard
Pg	Garber	Fine-grained sandstone; shale, chert and mudstone conglomerate	150-400	flat-lying	Gently rolling and broad flat plains	Major regional aquifer
Psp	Salt Plains	Blocky shale and siltstone	200	flat-lying	Not exposed	Aquiclude

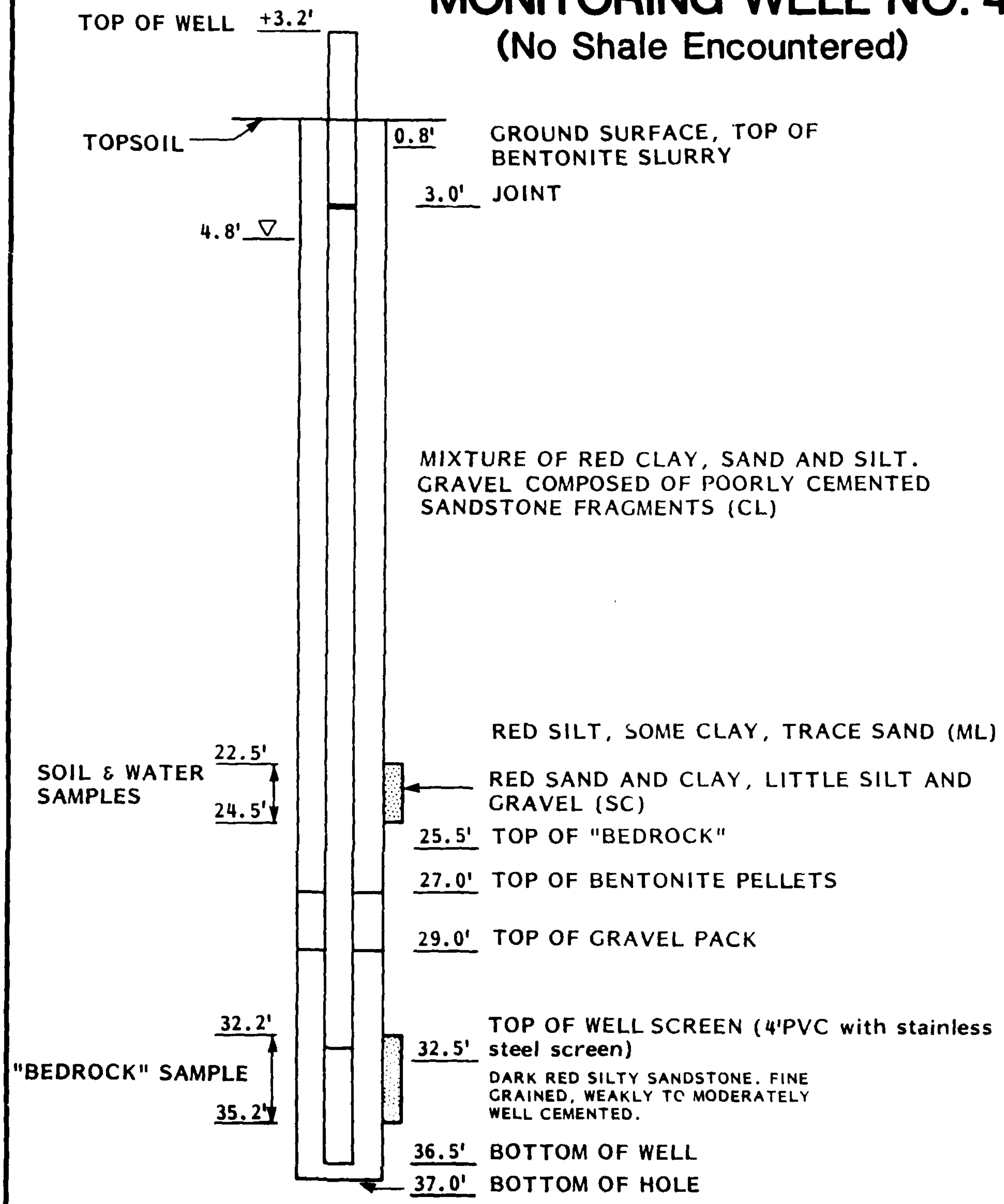
Source: Bingham and Moore (1975)
Johnson and Luza (1980)

FIGURE 3.4

TINKER AFB

MONITORING WELL NO. 4

(No Shale Encountered)



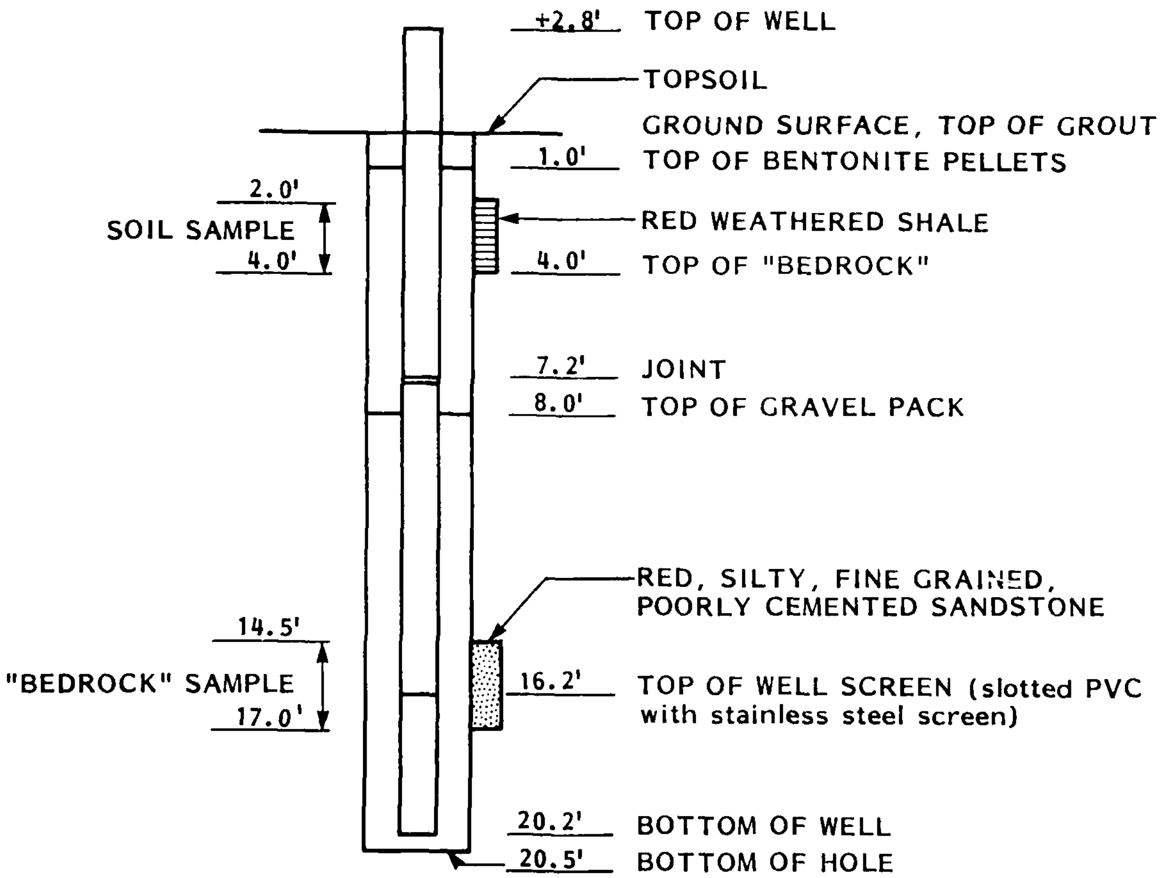
NOTE: GROUND-WATER LEVEL MEASURED AT TIME OF DRILLING AT 4.8'. THIS MAY ONLY REFLECT THE WATER LEVEL OF A NEARBY POND NOTED ON DRILLER'S LOG.

SOURCE: TINKER AFB DOCUMENTS

TINKER AFB

MONITORING WELL NO. 8

(Shale Encountered)



NOTE: DRY WELL – NO GROUND WATER ENCOUNTERED.

SOURCE: TINKER AFB DOCUMENTS

Wickersham (1979). Additional information has been obtained from interviews with officials of the Oklahoma Water Resources Board and the District Office, U.S. Geological Survey Water Resources Division and from the ground-water quality monitoring program presently being implemented at Tinker AFB.

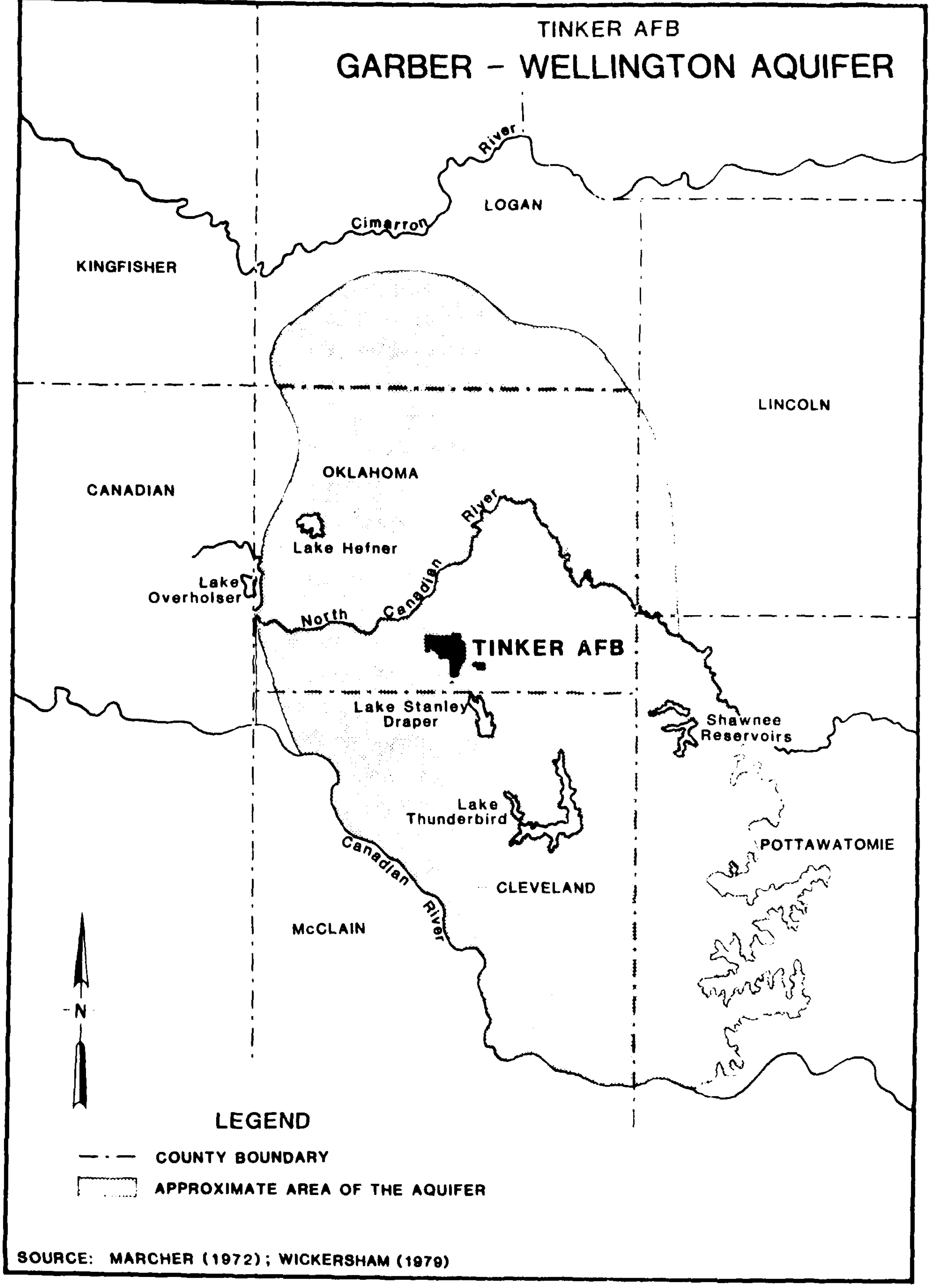
Garber-Wellington Aquifer

Tinker Air Force Base lies within the limits of the Garber-Wellington Ground-Water Basin. The Garber Sandstone and the Wellington Formation are considered to be a single aquifer and provide the most significant source of ground-water supplies in the Oklahoma City area. At the present time, Tinker Air Force Base derives most of its water supplies from this aquifer and supplements the supply by purchasing from the Oklahoma City Water Department. The nearby communities of Midwest City, and Del City derive water supplies from both surface sources and wells tapping the aquifer. Industrial operations, individual homes, farm irrigation, and small communities not served by a municipal distribution systems also depend on the Garber-Wellington Aquifer. Communities presently depending upon surface supplies such as Oklahoma City also maintain a well system drilled into the Garber-Wellington as a standby source of water in the event of drought. The aquifer area is depicted in Figure 3.6.

The Garber Sandstone and the Wellington Formation are considered to be a single aquifer as they were deposited under similar conditions and consist of lenticular beds of sandstone, siltstone and shale that tend to vary in thickness over relatively short horizontal distances (Wood and Burton, 1968). The sediments constituting the aquifer tend to be loosely cemented and have a maximum thickness of some 1,000 feet. In the area of outcrop, ground water occurs under water table (unconfined) conditions and may occur at relatively shallow depths below ground surface (100 to 150 feet). In areas overlain by younger geologic units, ground water occurs in the aquifer under artesian (confined) conditions and wells must be drilled deeper (200-250 feet) in order to encounter it (Wickersham, 1979).

The Garber-Wellington aquifer is exposed at ground surface or mantled by a thin soil over the northern two-thirds of Tinker Air Force Base. It is believed that the aquifer is overlain by a thin,

FIGURE 3.6

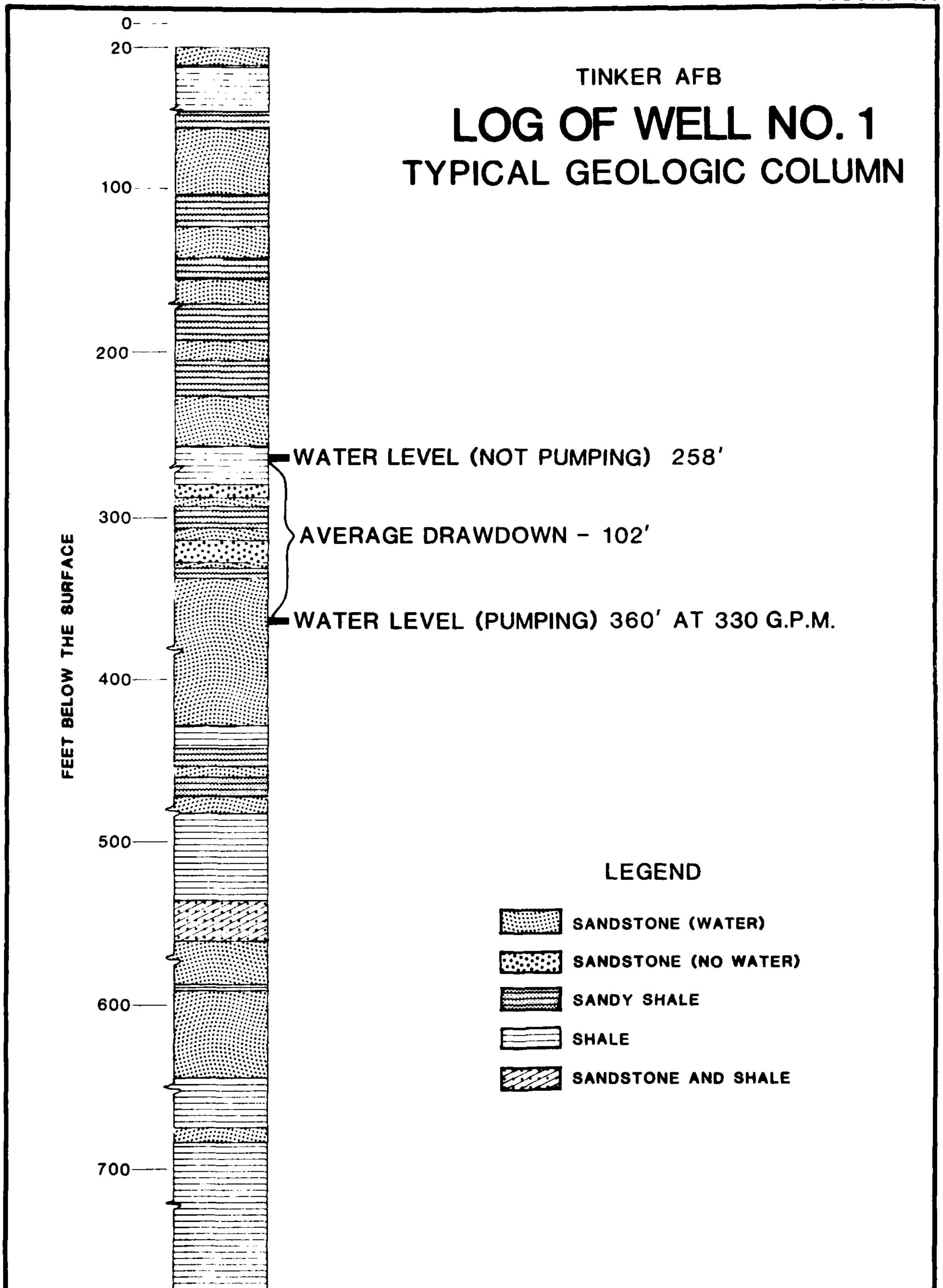


SOURCE: MARCHER (1972); WICKERSHAM (1979) discontinuous sequence of Hennessey Group sediments (Kingman Siltstone and Fairmont Shale) over the southern portion of the base. Water in the Garber-Wellington is normally encountered at a depth of some 100 feet at Tinker Air Force Base. Figure 3.7, a Tinker AFB well log, depicts local hydrogeology. A geologic cross-section of base wells developed by Wickersham (1979) is presented as Figure 3.8. This figure graphically depicts the lenticular nature of the sandy zones. Although most of the aquifer is believed to be saturated, multiple screened wells are usually constructed in order to obtain water from the more productive zones.

Recharge of the Garber-Wellington Aquifer is accomplished principally by percolation of surface waters crossing the area of outcrop and by rainfall infiltration in this same area. Because most of Tinker Air Force Base is located in an aquifer outcrop area, it is therefore assumed that this portion of the base is situated in a recharge zone (Havens, 1981). The aquifer is susceptible to contamination in the study area. Ground-water levels and flow directions (1976 data) are presented as Figure 3.9. According to the indicated hydraulic gradients, ground-water flow at Tinker AFB is presently directed to the northwest and south.

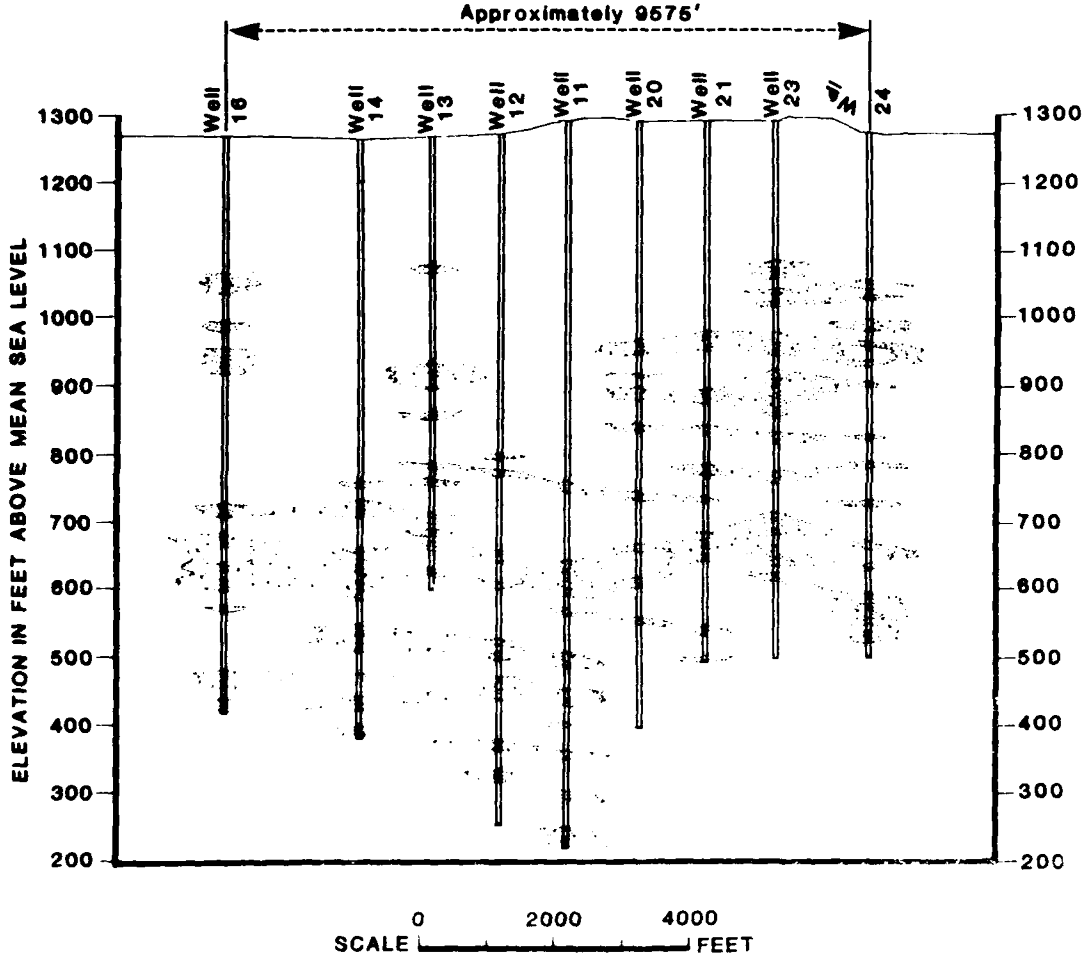
According to Wood and Burton (1968) and Wickersham (1979), the quality of ground water derived from the Garber-Wellington Aquifer is generally good, although wide variations in the concentrations of some constituents are known to occur. Wells drilled to excessive depths may encounter a saline zone, generally greater than 900 feet below ground surface. Wells drilled to such depths or those accidentally encountering the saline zone are either grouted over the lowest screens or may be abandoned.

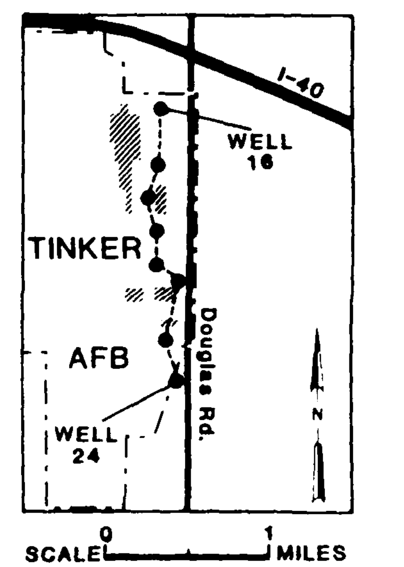
Tinker Air Force Base presently obtains its water supplies from a distribution system comprised of 27 water wells constructed along the east and west base boundaries, as shown by Figure 3.10 and by purchase from the Oklahoma City Water Department. All base wells are finished into the Garber-Wellington Aquifer. Base wells range from 700 to 900 feet in finished depth, with yields ranging from 205 to 250 gallons per minute. The wells incorporate multiple screens, deriving water supplies from sand zones that vary in thickness from 103-184 feet (Wickersham, 1979).



SOURCE: TINKER AFB DOCUMENTS (UNDATED)

GEOLOGIC SECTION OF THE GARBER-WELLINGTON AQUIFER AT TINKER AFB





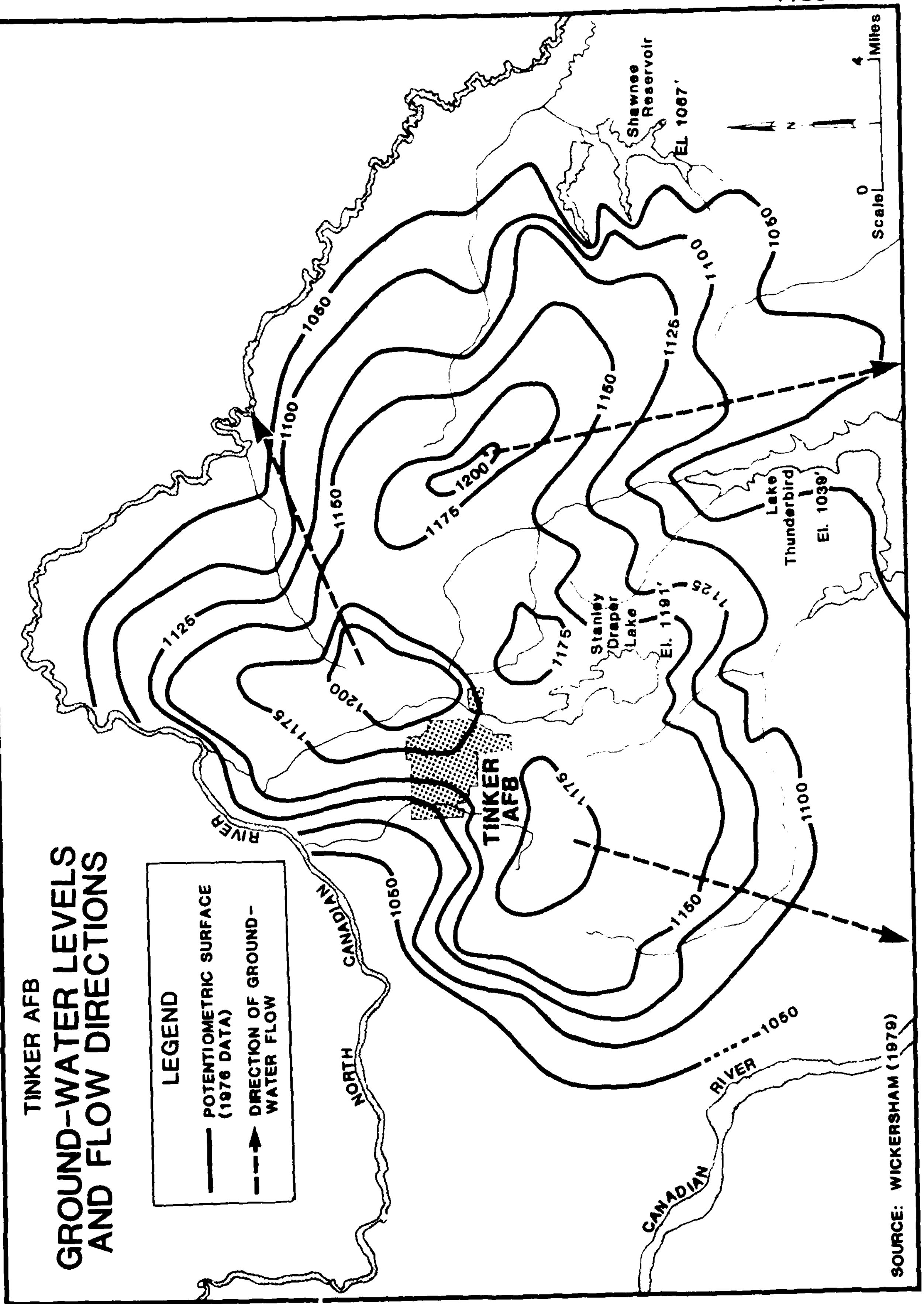
LEGEND

WATER-PRODUCING ZONE (SAND)

NONPRODUCING ZONE (SHALE/SILTSTONE)

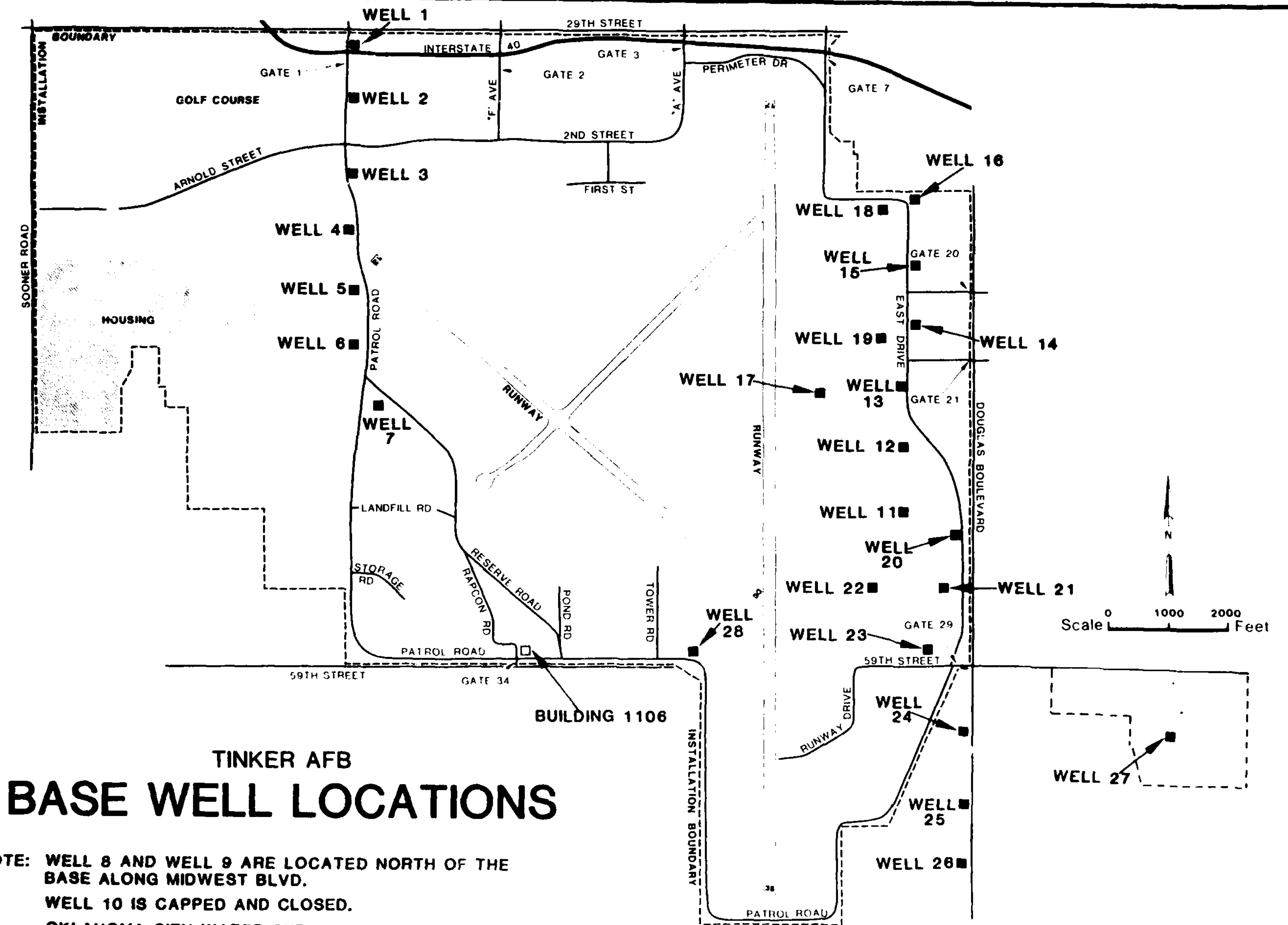
SOURCE: WICKERSHAM (1979)

FIGURE 3.9



TINKER AFB
GROUND-WATER LEVELS AND FLOW DIRECTIONS
LEGEND
POTENTIOMETRIC SURFACE (1976 DATA)
DIRECTION OF GROUND-WATER FLOW
NORTH CANADIAN RIVER
CANADIAN RIVER
TINKER AFB
Stanley Draper Lake El. 1191'
Lake Thunderbird El. 1039'
Shawnee Reservoir EL 1067'
Scale 0 4 Miles
N
1050
1100
1125
1150
1175
1200
SOURCE: WICKERSHAM (1979)

FIGURE 3.10



TINKER AFB

BASE WELL LOCATIONS

NOTE: WELL 8 AND WELL 9 ARE LOCATED NORTH OF THE BASE ALONG MIDWEST BLVD.

WELL 10 IS CAPPED AND CLOSED.

OKLAHOMA CITY WATER SUPPLY CONNECTION IS LOCATED AT BLDG 1106.

SOURCE: TINKER AFB DOCUMENTS

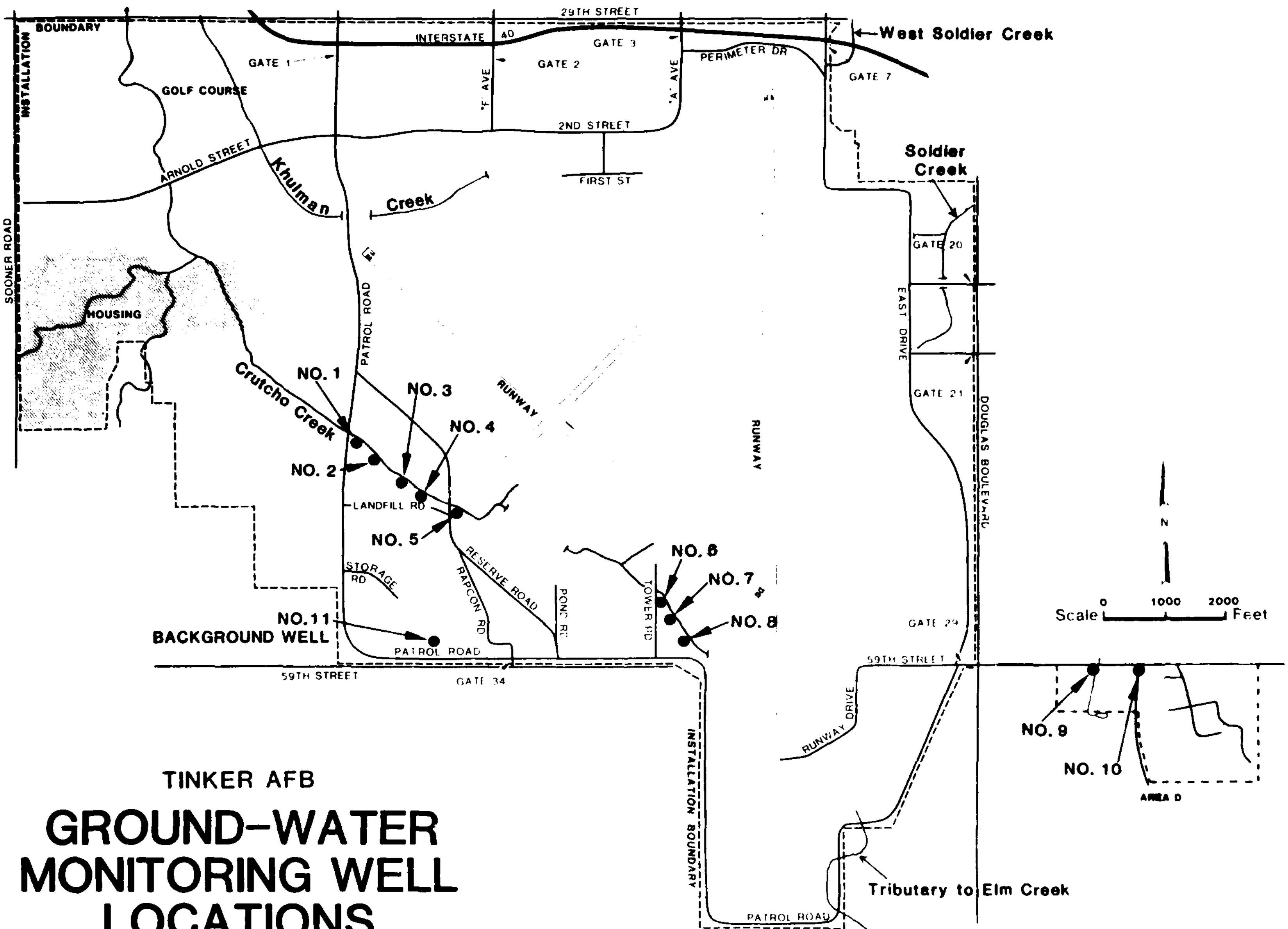
Shallow Aquifer Zones

Shallow aquifers may exist temporarily within the study area where zones of alluvium border streams or where shallow sandy residual soils may collect precipitation. At Tinker AFB, sandy residual soils overlying bedrock at shallow depths may form such an ephemeral aquifer. Soil aquifers are typically recharged directly by precipitation, gradually running dry seasonally as base flow to local streams and recharging of underlying rock aquifers deplete limited supplies. A local soil aquifer was encountered during ground-water quality monitoring recently underway at Tinker, AFB. Locations of the ground-water monitoring wells on base are shown in Figure 3.11. It is apparently perched above the Fairmont Shale at some locations and absent at others. The soil unit is moderately to highly permeable. Thickness of the soil unit varies from four to thirty feet and the depth to ground water in this unit varies from three to seventeen feet. In some cases, monitoring well logs indicated the absence of ground water in this unit. The significance of the shallow aquifer is that it may facilitate the contamination of important lower aquifers or surface waters by generation and mobilization of wastes. The shallow aquifer may not facilitate the detection of developing ground-water contamination problems because of their localized nature and ephemeral character. It is not known, to what degree if any, this aquifer communicates with base surface waters.

SURFACE WATER QUALITY

Tinker AFB has several streams and surface drainage systems which originate or flow through the base property. These streams have been monitored routinely at several locations by the base Bioenvironmental Engineering Office (BESD). In addition, special sampling studies have been conducted by the US Geological Survey, Oklahoma Water Resources Board and a student at the University of Oklahoma conducting research for his Ph.D dissertation (Frank, 1969). The on-base sampling stations are depicted on Figure 3.12 and summaries of the data evaluated are included in Appendix C. The data are discussed in the following paragraphs by sub-basins. In most instances there were no water quality limits on these surface streams in the past.

FIGURE 3.11



TINKER AFB

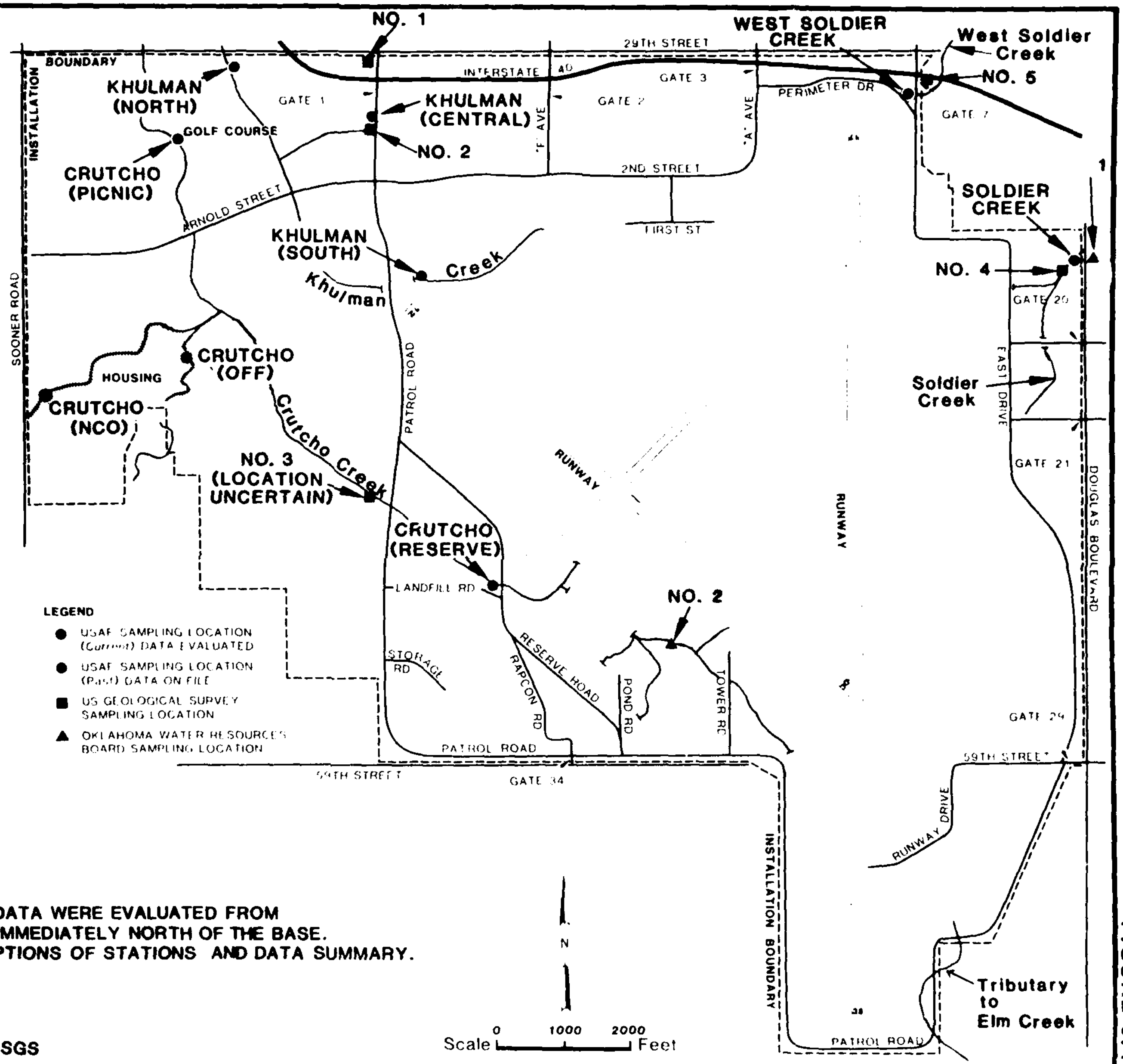
GROUND-WATER MONITORING WELL LOCATIONS

SOURCE: TINKER AFB DOCUMENTS

FIGURE 3.12

TINKER AFB

WATER QUALITY SAMPLING LOCATIONS



NOTE: ADDITIONAL WATER QUALITY DATA WERE EVALUATED FROM THREE SAMPLING LOCATIONS IMMEDIATELY NORTH OF THE BASE. SEE APPENDIX C FOR DESCRIPTIONS OF STATIONS AND DATA SUMMARY.

SOURCE: TINKER AFB DOCUMENTS; USGS

Crutcho Creek and its tributaries traverse the southern and western portions of the base. The earlier water quality data evaluated (USGS data collected during 1963) revealed lead values of 45 μg/l. Data collected from Crutcho Creek in 1968 (Frank, 1969) indicated concentrations of total chromium ranging from 50 to 1,800 μg/l and concentrations of cadmium ranging from 80 to 300 μg/l. Recent data collected by the base BESD (1980) indicated the levels of chromium were typically below 50 μg/l (the detectable limit of the test procedure used). One monthly sample during 1980 did however indicate 54 μg/l of chromium. Cadmium concentrations for Crutcho Creek were consistently below 10 μg/l during 1980.

Khulman Creek originates on base from surface drainage and storm runoff and drains the north central portion of the base. The 1963 USGS data revealed chromium values of 129 μg/l and cadmium values of 26 μg/l. The 1980 data showed iron concentrations ranged from 0.12 to 3.1 mg/l and manganese concentrations ranged from <0.050 to 4.5 mg/l. On occasions, oil and grease were also detected in the 1980 samples. West Soldier Creek originates on base and drains the northeast portion of the base. The 1963 USGS data revealed high metals contamination in the creek. The cadmium concentration was in the range of 46,000 μg/l and the chromium concentration was in the range of 31,000 μg/l. Aluminum, iron manganese and nickel were also analyzed and their respective concentrations were 620, 540, 1,400 and 242 μg/l. These high metals concentrations may have originated from direct discharge of industrial wastes and industrial spillage into the stream. Since the 1963 sampling, new controls and treatment measures have been implemented on base reducing the metal concentrations in the streams. By 1968, the surface water discharge contained chromium and cadmium concentrations of 7,200 μg/l and 2,000 μg/l respectively (Frank, 1969). The 1979 BESD data indicated a significant reduction of chromium and cadmium concentrations had occurred in the creek. Occasionally elevated levels of oil and grease and phenol were detected.

Soldier Creek originates on base and drains the eastern portion of the base. The domestic and industrial wastewater treatment plants presently contribute the majority of the creek's flow. The 1963 USGS data revealed chromium concentrations of 2,950 μg/l and cadmium concentrations of 2,180 μg/l. Nickel and manganese were detected at 129 and 58 μg/l, respectively. The 1968 University of Oklahoma data detected chromium concentrations within the range of 250 to 3,400 μg/l. Cadmium ranged from 30 to 2,800 μg/l, nickel ranged from 200 to 6,500 μg/l and iron range from 0.44 to 14 mg/l. BESD data collected in 1980 detected consistently high concentrations of total chromium; however hexavalent chromium, the valence state considered to be toxic, was consistently below the primary drinking water standard (50 μg/l). Cadmium concentrations were at or below the 10 μg/l drinking water standards. Nickel was the only parameter which was consistently detected at levels higher than the recent EPA ambient water quality criterion of 13.4 μg/l.

In addition to the water quality sampling conducted on the base, in 1981, the Oklahoma Water Resources Board collected sediment samples from Soldier Creek and soil samples from Crutcho Creek. The Soldier Creek samples had high levels of chromium, nickel and cadmium. The Crutcho Creek sample was collected near the fire training area and had levels of COD, oil and grease, and lead above background levels.

SUMMARY OF ENVIRONMENTAL SETTING

The environmental setting data reviewed for this study indicate the following key items concerning the impact of past waste disposal practices on the base:

- Surficial soils at Tinker AFB are predominantly sands or silts which characteristically exhibit moderate to high permeabilities.
- The primary regional aquifer, the Garber-Wellington, is present at or near ground-surface over most of the base area. Ground water is encountered within the aquifer at moderate depth (250 feet). The upper section of the aquifer is primarily an unsaturated zone.
- Tinker AFB is located within a recharge area of the primary regional aquifer.

- The historical contamination of base surface waters and associated sediments has been documented. Stream water percolation is known to be one form of recharge to the Garber-Wellington Aquifer.
- The Tinker AFB mean annual precipitation is 32.4 inches, while lake evaporation is given at 60 inches as Tinker AFB is located in a water deficient zone of the U.S. Precipitation events releasing as much as 6.2 inches rainfall in a twenty-four hour period at Tinker AFB have been reported, causing local flooding (Weather Squadron Data).

From these conditions it may be concluded that the potential for the contamination of the major regional aquifer exists. This potential exists because recharge of aquifer occurs where rainfall directly contacts the aquifer or where streams cross the area of outcrop. The aquifer is exposed at Tinker AFB and is therefore vulnerable to contamination at the base. Contaminant transport would primarily result from heavy rainfall events causing rapid over and flow and localized flooding. Contaminants would be expected to infiltrate through the unsaturated position of the aquifer with recharging meteoric waters, eventually reaching the ground-water reservoir.

CHAPTER 4

FINDINGS

CHAPTER 4

FINDINGS

To assess hazardous waste management at Tinker Air Force Base, waste generation and disposal methods were reviewed. This chapter summarizes the hazardous waste generated by activity, describes waste disposal methods, identifies the disposal sites located on the base and evaluates the potential for contaminant migration. Figure 4.1 presents the decision tree methodology used in the review of waste practices. The methodology provides a logical algorithm for the consistent evaluation of all base practices.

PAST SHOP AND BASE ACTIVITY REVIEW

To identify past base activities that resulted in generation and disposal of hazardous waste, a review was conducted of current and past waste generation and disposal methods. This review consisted of interviews with base employees, a search of files and records, and site inspections.

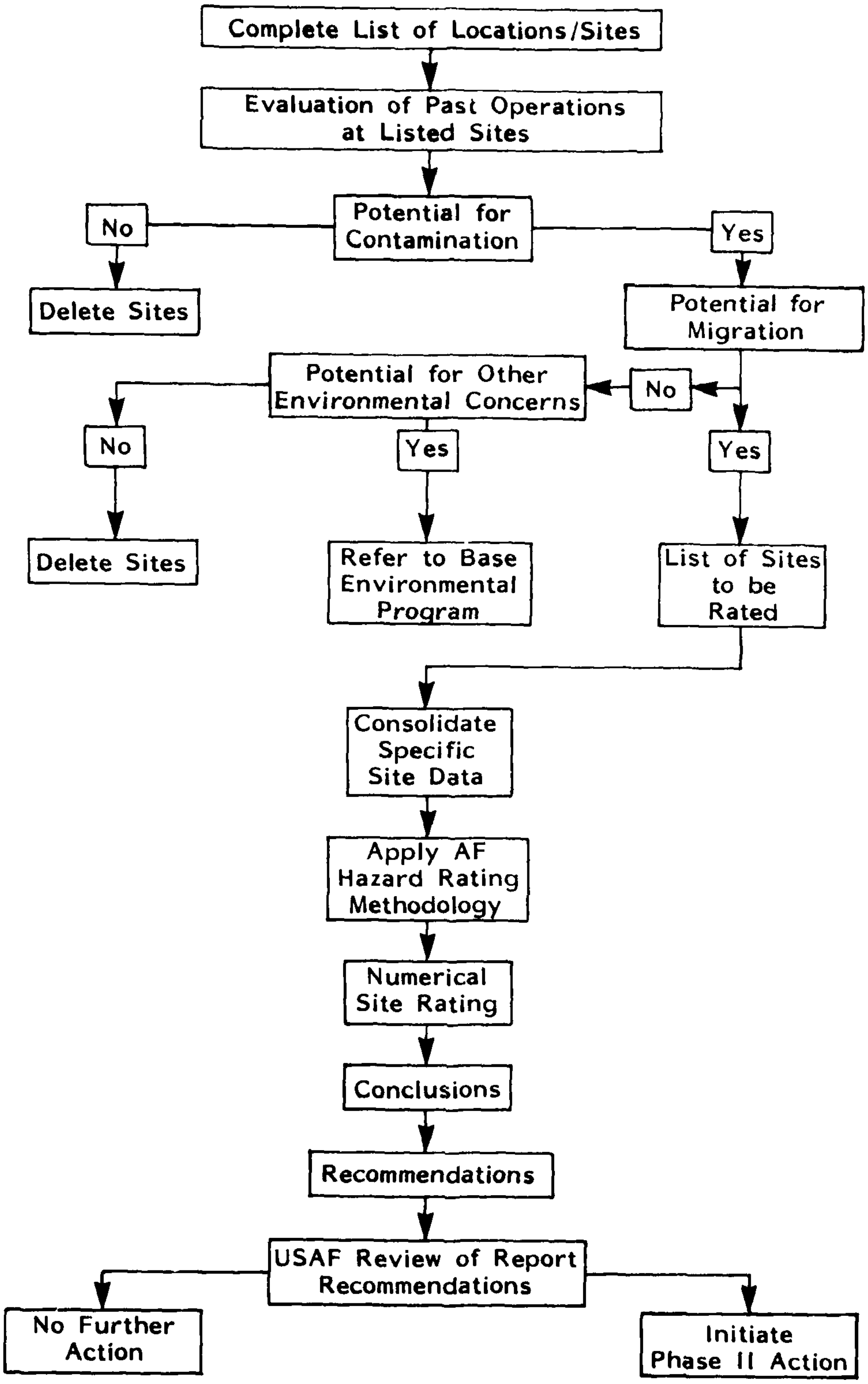
The sources of most hazardous waste that are generated on Tinker AFB can be associated with one of the following activities:

- Industrial shops
- Fire control training
- Pesticide utilization
- Fuels management
- Industrial Waste Treatment

The following discussion addresses only those wastes generated on base which are either hazardous or potentially hazardous. In this discussion a hazardous waste is defined as hazardous by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) or by the Tinker AFB documents which have been reviewed. A potentially hazardous waste is one which is suspected of being hazardous although insufficient data are available to fully characterize the waste material.

PHASE I INSTALLATION RESTORATION PROGRAM

DECISION TREE



Industrial Shops

The industrial operations at Tinker AFB can be divided into two major groups as follows: The Directorate of Maintenance and other base maintenance support activities. The Directorate of Maintenance provides facilities for servicing and repairing various types of aircraft and jet engines. Five major divisions embody most of the shop activities for the Directorate of Maintenance. The divisions include the Aircraft Division, Plant Management Division, Propulsion Division, Quality Division and Accessories Division. The greatest quantity of waste materials generated at Tinker AFB were from the Directorate of Maintenance areas.

Other base maintenance support activities are the industrial shops from the Directorate of Distribution, the 2854 Air Base Group, the 2854 Civil Engineering Squadron, the 3rd Combat Communications Group, the 6th Weather Squadron, the 507 Tactical Fighter Group and the 552 Aircraft Warning and Control Wing. These industrial operations include primarily vehicle, electrical and aircraft maintenance and repair.

To assess those shops which handle hazardous materials and/or generate hazardous waste, a review was made of the Bioenvironmental Engineering Office shop files. The results of this file review are shown in Appendix D, Master List of Industrial Shops.

Following the compilation of a master list of industrial shops, personnel within the Directorate of Maintenance and other base maintenance support functions were interviewed. A timeline of disposal methods was established for major waste generated. The information from the interviews with base personnel is summarized in Table 4.1. This table shows the building locations as well as the waste material names, waste quantities, and disposal method timeline.

TABLE 4.1

INDUSTRIAL OPERATIONS (Shops)

HAZARDOUS WASTE MANAGEMENT

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY (1)	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980
DIRECTORATE OF MAINTENANCE				
THE FOLLOWING PETROLEUM WASTE ITEMS HAVE BEEN CONSOLIDATED FOR ALL DIVISION SHOPS	NA	RECLAIMABLE WASTE OIL	22,000 GALS./YR.	INDUSTRIAL WASTE PITS → DRUMMED TO DPDO CONTRACTOR
		RECLAIMABLE WASTE FUEL	30,000 GALS./YR.	INDUSTRIAL WASTE PITS → DRUMMED TO DPDO CONTRACTOR
		WASTE FUELS AND FLUIDS	250,000 GALS./YR.	INDUSTRIAL WASTE PITS → DRUMMED TO DPDO CONTRACTOR
		WASTE CALIBRATION FLUID	140,000 GALS./YR.	INDUSTRIAL WASTE PITS → DRUMMED TO DPDO CONTRACTOR
		CHLORINATED SOLVENTS (2)	15,000 GALS./YR.	INDUSTRIAL WASTE PITS → DRUMMED TO DPDO CONTRACTOR
<u>AIRCRAFT DIVISION</u>				
COMPOSITE - ALL SHOPS	2122, 2280 3001	PAINT STRIPPER, PHENOLIC	400 GALS./DAY	STORM SEWERS → DISCHARGE TO IWTP (3)
		METHYL ETHYL KETONE (MEK)	55 GALS./DAY	INDUSTRIAL WASTE PITS → DRUMMED TO MADE (4) CONTRACTOR
		PAINT STRIPPER SLUDGES	150 GALS./DAY	INDUSTRIAL WASTE PITS → DRUMMED TO MADE CONTRACTOR
<u>PROPULSION DIVISION</u>				
ELECTROPLATING AREAS	3001	CHROME PLATING WASTES	30,000 GALS./YR.	INDUSTRIAL WASTE PITS → ON-BASE IWTP OR OFF-BASE MADE CONTRACTOR (5)
		ALKALINE CYANIDE WASTES	37,300 GALS./YR.	INDUSTRIAL WASTE PITS → ON BASE IWTP OR OFF-BASE MADE CONTRACTOR
		MIXED WASTE ACIDS	77,000 GALS./YR.	INDUSTRIAL WASTE PITS → IWTP OR MADE CONTRACTOR
		VARIOUS PLATING SOLUTIONS	2,000 GALS./YR.	INDUSTRIAL WASTE PITS → MADE CONTRACTOR
		PERCHLOROETHYLENE/WAX	7,300 GALS./YR.	INDUSTRIAL WASTE PITS → MADE CONTRACTOR
		CONTAMINATED VAT RIM HOODS	150 DRUMS/YR.	1950 BASE LANDFILLS → MADE CONTRACTOR
CLEANING AREAS	3001	CARBON REMOVER (6)	18,900 GALS./YR.	1955 INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR
		ALKALINE CLEANERS	22,400 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		CHROMIC/PHOSPHORIC ACID	3,500 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR

KEY

——— CONFIRMED TIME-FRAME DATA BY SHOP PERSONNEL

------ ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

(1) BASED ON CURRENT RATES AND BEST ESTIMATES OF PAST RATES. PAST RATES ARE ESTIMATED TO BE BETWEEN 40% AND 70% OF VALUES SHOWN

(2) INCLUDING TRICHLOROETHANE, PERCHLOROETHYLENE AND FREON

(3) IWTP - INDUSTRIAL WASTE TREATMENT PLANT

(4) MADE - PLANT MANAGEMENT DIVISION OFFICE SYMBOLS, RESPONSIBLE FOR DISPOSAL CONTRACTORS

(5) INDICATES A CHOICE IS MADE BY "MADE" TO EITHER TREAT THE WASTES ON BASE AT THE IWT FACILITY OR OBTAIN AN OFF BASE CONTRACTOR TO TRANSPORT AND DISPOSE OF THE WASTE

(6) CONTAINS ORTHO DICHLOROBENZENE AND CRESYLIC ACID

TABLE 4.1 (cont'd.)

INDUSTRIAL OPERATIONS (Shops)

HAZARDOUS WASTE MANAGEMENT

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL (1950 – 1960 – 1970 – 1980)
PROPULSION DIVISION (cont'd.)				
CLEANING AREAS (cont'd.)	3001	RUBBER REMOVER	1,100 GALS./YR.	1976 → MADE CONTRACTOR
		PHOSPHORIC ACID	45,000 GALS./YR.	INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR
		HOT TANK STRIPPER	5,000 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		EMULSION CLEANER	5,000 GALS./YR.	1976 → MADE CONTRACTOR
		NITRIC/HYDROFLUORIC ACID	1,000 GALS./YR.	INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR
		PERCHLOROETHYLENE WASTES	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
NON DESTRUCTIVE INSPECTION	3001	PENETRANT	1,800 GALS./YR.	1955 INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		DEVELOPER	1,500 GALS./YR.	1955 INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		EMULSIFIER	16,300 GALS./YR.	1955 INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR
PAINT AREAS	3001	THINNERS	1,700 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		WASTE PAINTS	7,000 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		ACETONE	1,375 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
MACHINE SHOP AREAS	3001	COOLANT OIL	80,000 GALS./YR.	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		MAGNESIUM THORIUM	600 LBS./YR.	1964 NEVADA AEC DISPOSAL SITE 1975
ACCESSORIES DIVISION				
COMPOSITE ALL SHOPS	229, 230,	CARBON REMOVER (6)	2,100 GALS./YR.	INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR
	3001, 3113	ALKALINE CLEANERS	5,600 GALS./YR.	INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR

KEY

——— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL

- - - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

TABLE 4.1 (cont'd.)

INDUSTRIAL OPERATIONS (Shops)

HAZARDOUS WASTE MANAGEMENT

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL (1950 – 1960 – 1970 – 1980)
ACCESSORIES DIVISION (cont'd.)				
COMPOSITE ALL SHOPS (cont'd.)	229, 230, 3001, 3113	PERCHLOROETHYLENE	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		TRICHLOROETHANE	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		FREON	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		PAINT WASTES	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		THINNERS	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
		STRIPPERS, PHENOLIC	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → IWTP OR MADE CONTRACTOR
		COOLANT OIL	INCLUDED ABOVE	INDUSTRIAL WASTE PIT → MADE CONTRACTOR
MERCURY SHOP	230	MERCURY CONTAMINATED WASTES & FILTERS	5 LBS./2 MOS.	1950 UNKNOWN → FORT McCELLAN RECOVERY → DPDO
2854 AIR BASE GROUP				
PHOTO LAB	1	FIXER SOLUTIONS	300 GALS./5 MOS.	1953 SILVER RECOVERY THROUGH DPDO → IN HOUSE SILVER RECOVERY
		OTHER PHOTOGRAPHIC SOLNS.	50 GALS./MO.	1953 DISCHARGE TO SANITARY SEWER
VEHICLE TRANSPORTATION DIVISION	2101	WASTE OILS	300 GALS./MO.	INDUSTRIAL WASTE PIT → DRUMMED TO CES CONTRACTOR
		WASTE FUELS	100 GALS./MO.	INDUSTRIAL WASTE PIT → PUMP OUT TO CES CONTRACTOR
		O/W[7] SEPARATOR SLUDGE	20 GALS./MO.	INDUSTRIAL WASTE PIT → PUMP OUT TO CES CONTRACTOR
2854 CIVIL ENGINEERING SQUADRON (CES)				
LIQUID FUEL SYSTEMS MAINTENANCE	246	FUEL STORAGE TANK SLUDGE	80 GALS./YR.	TANK SLUDGE SPREAD AREA → DRUMMED TO CES CONTRACTOR
ENTOMOLOGY UNIT	773	SPRAYER RINSE WATER	300 GALS./MO.	1950 DISCHARGE TO STORM SEWER → DRUMMED TO CES CONTRACTOR
		METAL RINSED CONTAINERS (5 GALS.)	5 EA./MO.	1950 ON BASE LANDFILL → DPDO

KEY

——— CONFIRMED TIME-FRAME DATA BY SHOP PERSONNEL

- - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

(7) O/W OIL/WATER

TABLE 4.1 (cont'd.)

INDUSTRIAL OPERATIONS (Shops)

HAZARDOUS WASTE MANAGEMENT

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL (1950 / 1960 / 1970 / 1980)
3 COMBAT COMMUNICATIONS GROUP (CCG)				
VEHICLE MAINTENANCE	1001	WASTE OIL	300 GALS./WK.	1955 INDUSTRIAL WASTE PIT; DRUMMED TO CES CONTRACTOR
6 WEATHER SQUADRON				
VEHICLE MAINTENANCE	2101	WASTE OILS, PAINT THINNERS	110 GALS./YR.	1955 INDUSTRIAL WASTE PIT; DRUMMED TO CES CONTRACTOR
		CLEANING SOLVENTS	110 GALS./YR.	1955 INDUSTRIAL WASTE PIT; DRUMMED TO CES CONTRACTOR
507 TACTICAL FIGHTER GROUP (TFG)				
THE PETROLEUM PRODUCTS LISTED AT RIGHT ARE CONSOLIDATED FOR ALL SHOPS.	1030, 1041, 1070	RESALABLE JET FUEL	1,000 GALS./MO.	1957 DRUMMED TO DPDO
		WASTE JET FUEL	100 GALS./MO.	1957 ON BASE LANDFILL; PUMP OUT TO CES CONTRACTOR
		SYNTHETIC OILS	16 GALS./MO.	1957 ON BASE LANDFILL; PUMP OUT TO CES CONTRACTOR
		HYDRAULIC FLUID ON RAGS, etc.	55 GALS./YR.	1957 ON BASE LANDFILL; CITY LANDFILL
CORROSION CONTROL	1030	PAINT THINNERS, MEK	[illegible] GALS./90 DAYS	1957 ON BASE LANDFILLS; DRUMMED TO DPDO
NON DESTRUCTIVE INSPECTION (NDI)	1030	PENETRANT	55 GALS./YR.	(NO NDI FUNCTION) 1972 DPDO
		DEVELOPER	55 GALS./YR.	(NO NDI FUNCTION) 1972 DPDO
		HYPOPHOTOGRAPHIC SOLUTION	55 GALS./YR.	(NO NDI FUNCTION) 1972 DPDO
ARMAMENT/GUN SHOP	1030	PD 680	55 GALS./YR.	1957 ON BASE LANDFILL; PUMP OUT TO CES CONTRACTOR

KEY

——— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL

- - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

TABLE 4.1 (cont'd.)

INDUSTRIAL OPERATIONS (Shops)

HAZARDOUS WASTE MANAGEMENT

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL (1965 1970 1975 1980)
552 AIRCRAFT WARNING & CONTROL WING (AWACW)				
AIRCRAFT GENERATION SQUADRON (AGS)				
E3A & C135 AIRCRAFT MAINT. UNITS	230	WASTE OILS, FUELS, FLUIDS	400 GALS./MO.	1977 → DRUMMED TO CES CONTRACTOR
COMPONENT REPAIR SQUADRON (CRS)				
CORROSION CONTROL	289	SEPARATOR WASTE SLUDGE	50 GALS./MO.	1977 → PUMP OUT TO CES CONTRACTOR
		PAINT STRIPPERS	20 GALS./WK.	1977 → IWTP
		SOLVENTS, THINNERS	55 GALS./3 MOS.	1977 → DRUMMED TO ON BASE STORAGE[8]
FUEL CELL SECTION	230	WASTE JET FUELS	20 GALS./MO.	1977 → DRUMMED TO CES CONTRACTOR
AIRCRAFT GROUND EQUIPMENT BRANCH	228	WASTE OILS, PD 680, HYDRAULIC FLUIDS, SOLVENTS	100 GALS./WK.	1977 → DRUMMED TO CES CONTRACTOR
		SEPARATOR WASTE SLUDGE	30 GALS./MO.	1977 → PUMP OUT TO CES CONTRACTOR

KEY

——— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL

------ ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

[8] ON BASE STORAGE OF HAZARDOUS WASTES IS PROVIDED AT THE OLD WASTEWATER TREATMENT PLANT PENDING FINAL DISPOSAL OFF BASE.

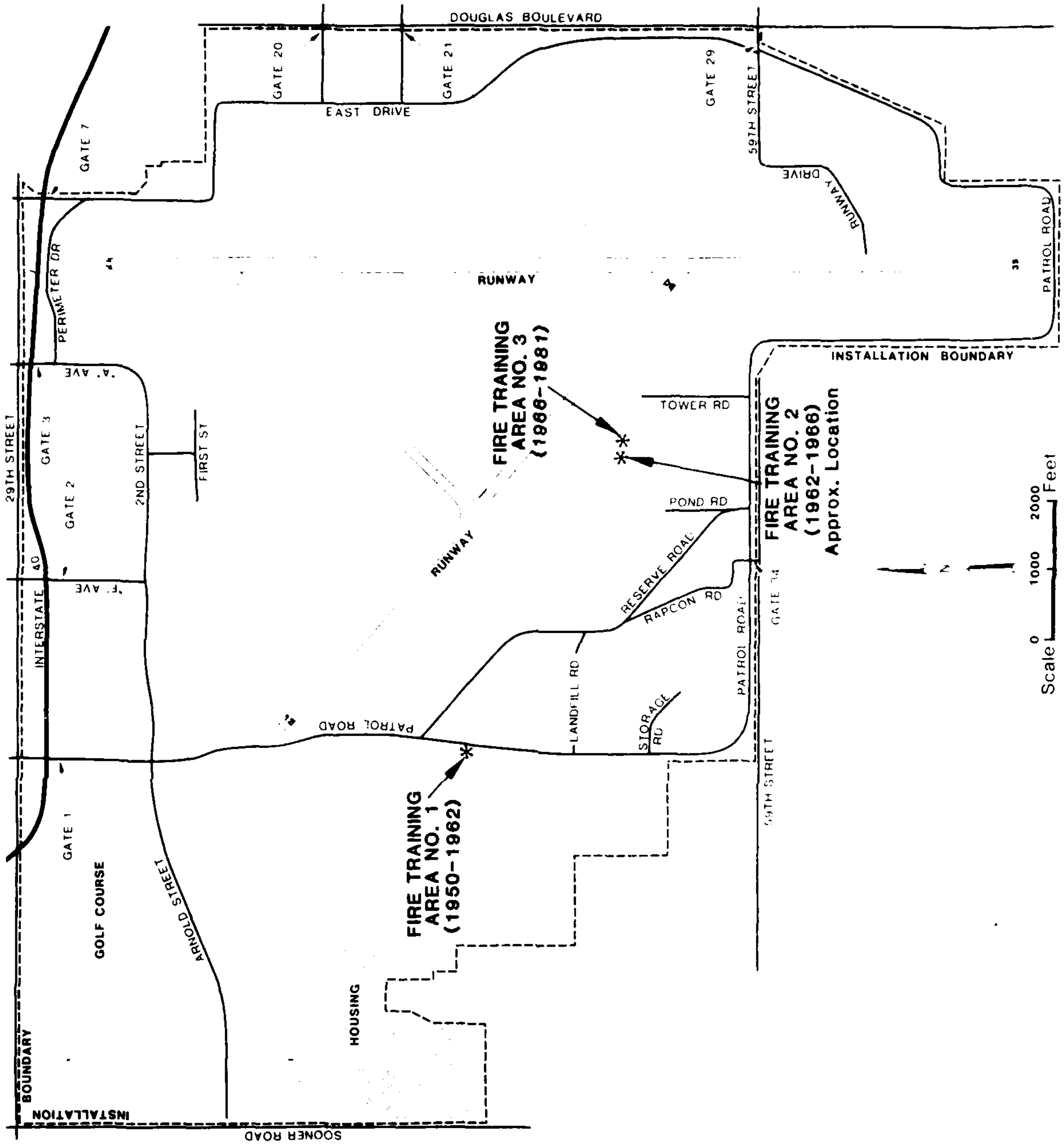
Many wastes generated from industrial operations were disposed of in waste disposal pits located south of Building 2121 from 1947 to 1965. These waste included: phenols, plating wastes, acids, and cyanide waste. When the waste disposal pits were closed, Civil Engineering Squadron (CES) began providing contractor pickup and disposal for waste materials off-base. In 1969 the Directorate of Maintenance began arranging for outside contractor pickup of waste materials from their shops and divisions. At this point the Civil Engineering Squadron provided outside contractor waste pickup and disposal only for on-base tenant Air Force units.

Fire Protection Training

Fire Protection Training (FPT) activities of the Fire Department on Tinker AFB commenced about 1950. Since that time, three Fire Training Areas (FTA) have been utilized, as shown on Figures 4.2.

FTA No. 1 was located directly south of the abandoned wastewater treatment facility, north of Crutcho Creek, and west of Air Depot Boulevard as shown on Figure 4.3. The training pit was diked and had a gravel bottom, but was unlined. FPT activities were conducted from approximately 1950 to 1962 at this location, with the heaviest usage occurring in the early 1950's. The procedure was to first add water to the pit to saturate the soil and reduce infiltration and then fuel was added on top of the water. Although fuel oil was often burned in the fire training practice, sometimes the operation included the burning of waste material from 55-gallon drums. No information is available concerning the types of materials contained in these drums; however, it is likely that materials such as solvents and waste oils were consumed in FTA No. 1. After waste materials and/or fuel were added to the pit, it was ignited and then extinguished with water and/or a protein-based foam. The residual mixture remaining in the pit would evaporate or infiltrate into the soil prior to the next training exercise.

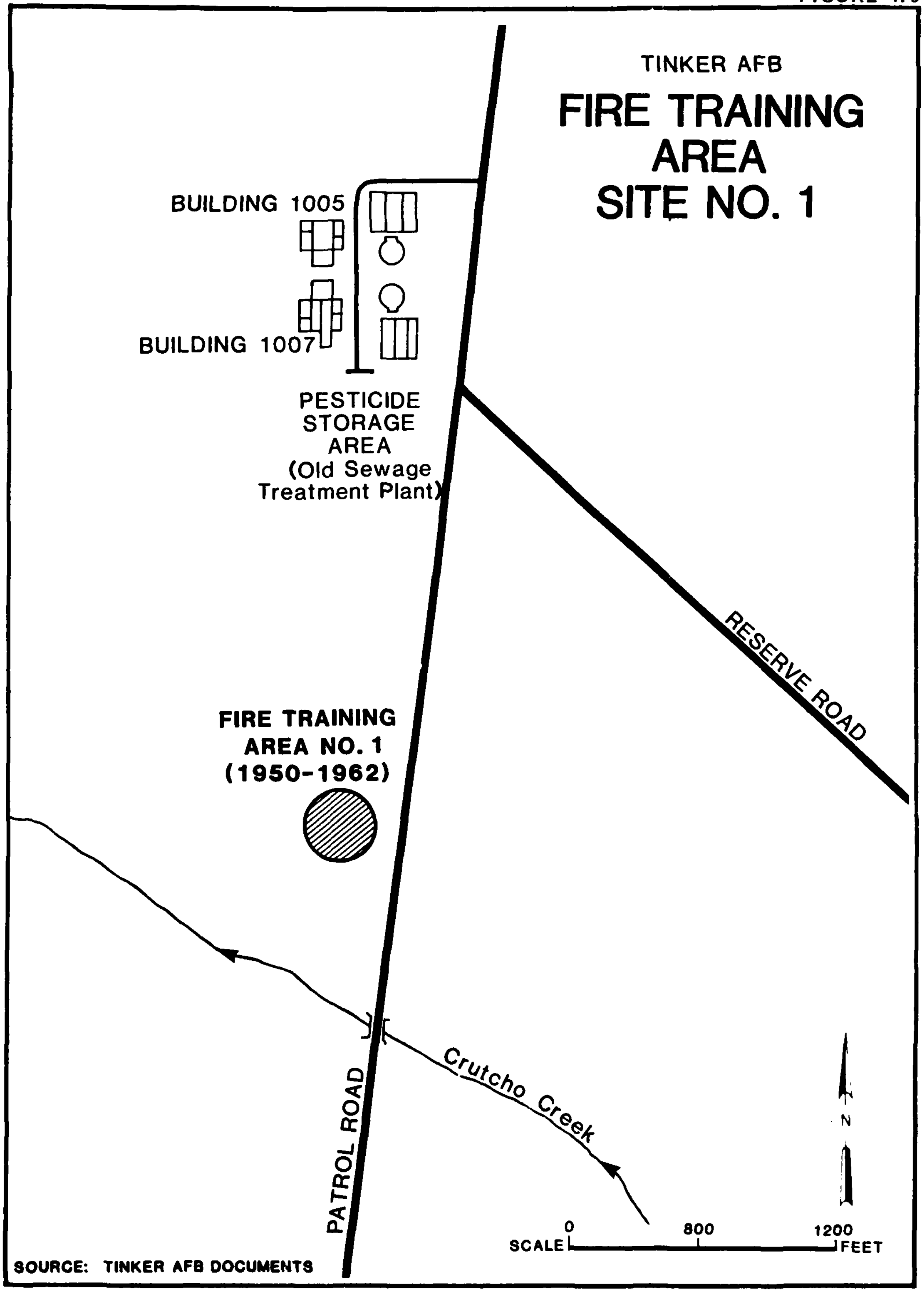
After closure of FTA No. 1, fire control training activities were conducted in a temporary pit (FTA No. 2) located several hundred feet west of the present site, as shown on Figure 4.4. The training pit, diked but unlined, was used infrequently between 1962 and 1966. The practice of disposing of drummed waste in the fire training area was discontinued at this time. Fuel was brought in by tank truck, ignited



TINKER AFB

FIRE TRAINING AREAS

SOURCE: TINKER AFB DOCUMENTS



SOURCE: TINKER AFB DOCUMENTS

and extinguished in the training pit in the same location. The residue was left in the pit to evaporate and infiltrate prior to the next exercise.

The Fire Department conducts training activities in FTA No. 3 located in the south central portion of the base, as shown on Figure 4.4. This site operated from 1966 to 1981. The training pit was unlined prior to the summer of 1981. The pit is presently being replaced with a concrete-lined training pit in the same location. Prior to training exercises, water was added to the pit to minimize infiltration. Both contaminated and uncontaminated JP-4 fuel have been used at this site. Approximately 600 to 700 gallons of fuel are used during a typical training exercise. After ignition, the fire is extinguished with water and a protein based foam. Training exercises occured only twice during 1979 and about once per month during 1980.

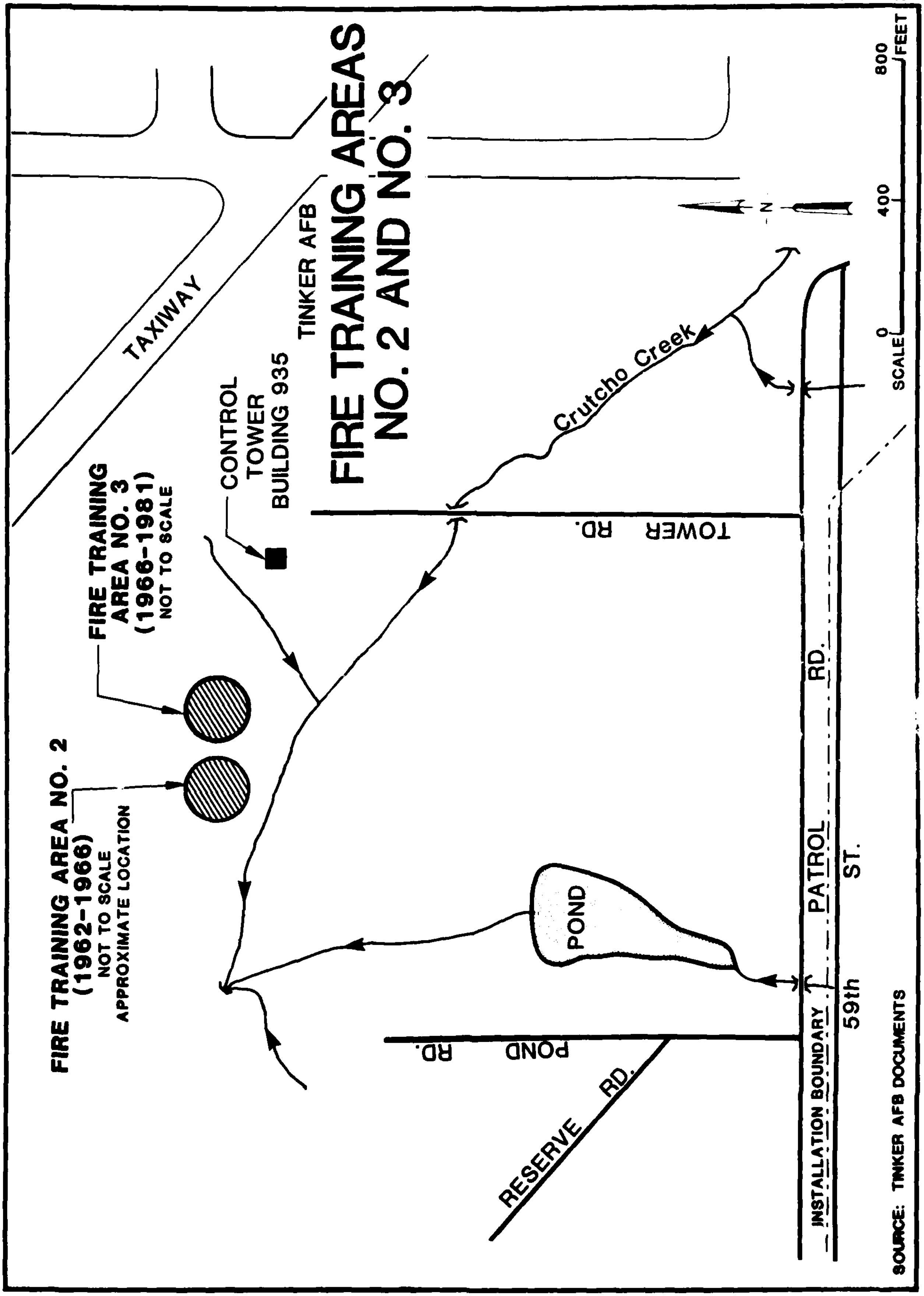
Although diked, overflow from FTA No. 3 had entered Crutcho Creek, according to a 1981 NPDES Compliance Inspection by the Oklahoma Water Resources Board. An area of dead vegetation was noted in the runoff path from the pit to West Crutcho Creek, and soil samples indicated high concentrations of COD and oil and grease were present. The base personnel implemented an excavation project to remove contaminated soil in the area of this training pit prior to constructing a new concrete lined facility as a result of the inspection and soil samples. Contaminated soil was also removed from the area between the pit and Crutcho Creek.

Pesticide Utilization

The pesticide program on Tinker AFB began in the early 1950's. Initially, the Entomology Shop conducted the insecticide program and the Grounds and Pavements Shop managed the herbicide program. In 1979, the Grounds and Pavements Shop transferred the responsibilities of the herbicide program to the Entomology Shop. Both shops are presently located in Building 773. Since 1975, all chemicals have been stored and mixed at the old domestic wastewater treatment plant along Air Depot Boulevard as shown in Figure 4.3. Both large truck-mounted sprayers and hand held sprayers are utilized. A variety of pest and weed control chemicals are used throughout the year.

The Entomology Shop personnel interviewed stated that poor quality chemicals are returned to the manufacturing company for disposal. Some

FIGURE 4.4



TINKER AFB
FIRE TRAINING AREAS
NO. 2 AND NO. 3
TAXIWAY
CONTROL TOWER BUILDING 935
FIRE TRAINING AREA NO. 3 (1966-1981) NOT TO SCALE
FIRE TRAINING AREA NO. 2 (1962-1966) NOT TO SCALE APPROXIMATE LOCATION
Crutcho Creek
TOWER RD.
POND
POND RD.
RESERVE RD.
PATROL RD.
INSTALLATION BOUNDARY
59th ST.
N
SCALE
0
400
800
FEET
SOURCE: TINKER AFB DOCUMENTS

off-specification chemicals may have been disposed in the landfills during the 1950's and early 1960's.

Prior to 1975, there were no procedures for collecting rinse water. All cleaning water was allowed to run off to areas adjacent to Building 773, which eventually drains to Khulman Creek. Since 1975, batches of spray equipment rinse water have been drained into an underground storage tank. The rinse water has been pumped from the underground tank approximately once a month by a contractor for off-base disposal.

Prior to 1971, pesticide containers were usually single rinsed, mashed and disposed with the base refuse in the base landfills which were in use. In 1971, the base started a procedure for triple rinsing the pesticide containers and collecting the rinse water in an underground tank. The containers were either punched with holes, crushed or cut up prior to their disposal with general base refuse. Beginning approximately 1978, all metal pesticide containers were taken to DPDO for disposal.

Fuels Management

Numerous aboveground and underground storage tanks are contained in the fuels management system at Tinker AFB. Avgas, mogas, alcohol, fuel oil, diesel, solvents, lube oil, JP-4, and JP-5 are all used on base. The fuel used in the greatest quantities is JP-4 at approximately 5,500,000 gallons per month. Two large storage tanks, for JP-4 and for fuel oil are located in the central base area. Many smaller storage tanks are located throughout the base. A summary of storage capacities for fuels and other products compiled from the base Spill Prevention, Control and Countermeasures (SPCC) Plan is shown in Table 4.2.

A pipeline between the central and east base areas has been used to transfer fuels. The pipeline was periodically pressure tested to identify leakage. Underground tanks were also tested for leakage by monitoring tank levels over a 48-hour period. Most aboveground tanks on base are diked or have other spill control measures.

Fuel spills occur periodically on base. A majority of these are minor spills on the order of several gallons per incident. Spill records from late 1978 to 1981 were reviewed to identify significant spills (defined as greater than 1000 gallons). Four significant spills were identified during this time period. Summary information on these

TABLE 4.2

TINKER AIR FORCE BASE FUELS STORAGE

Product	Number of Tanks	Max. Tank Vol. (gals.)	Min Tank Vol (gals.)	Approx. Storage (gals.)
JP-4, JP-5	35	2,314,000	1,000	5,094,400
Alcohol	1	25,000	25,000	25,000
Avgas	8	25,000	25,000	200,000
Mogas	13	18,000	4,000	145,000
Diesel	9	50,000	2,400	129,200
Solvents and Lube Oil & Calibration Fluid	15	18,000	1,300	128,500
Fuel Oil	10	1,050,000	12,850	1,436,600
Waste Oil/JP-4	4	12,000	12,000	48,000
Calibration Fluid	1	30,000	30,000	30,000

Source: Tinker AFB Documents

spills appears in Table 4.3. Reference was also found to a chemical spill in Crutcho Creek on March 22, 1981, although the magnitude of the spill was undetermined. Records of spills prior to 1978 could not be located, although long-time base personnel did not remember any major spills occurring in previous years.

The major waste items from fuels management area are used fuel line filters and tank bottom sludge. The used filters have been disposed as general refuse, and are eventually buried in the sanitary landfills. Sludge residue accumulates as tank bottoms in leaded fuel storage tanks. At Tinker AFB, leaded tank bottoms were weathered in a small area on top of landfill No. 4. This practice was discontinued in 1977. Since that time, leaded sludges have been handled by contractor disposal.

DESCRIPTION OF PAST ON-SITE DISPOSAL METHODS

The on-site facilities which have been used for management and disposal of waste can be categorized as follows:

- Landfills
- Industrial Waste Pits
- Radioactive Waste Disposal Sites
- Industrial Wastewater Treatment Plant
- Sanitary Wastewater Treatment Plant
- Storm Sewer System
- Ordnance Disposal Sites
- Defense Property Disposal office

These waste management facilities are discussed individually below.

Landfills

Six landfills used for the disposal of refuse were identified at Tinker AFB. Landfill locations on-base are shown on Figure 4.5. Five of the landfills are located on the base, and one is located on leased property adjoining Area "D" east of the base. Table 4.4 contains a summary of information on each landfill.

Landfill No. 1

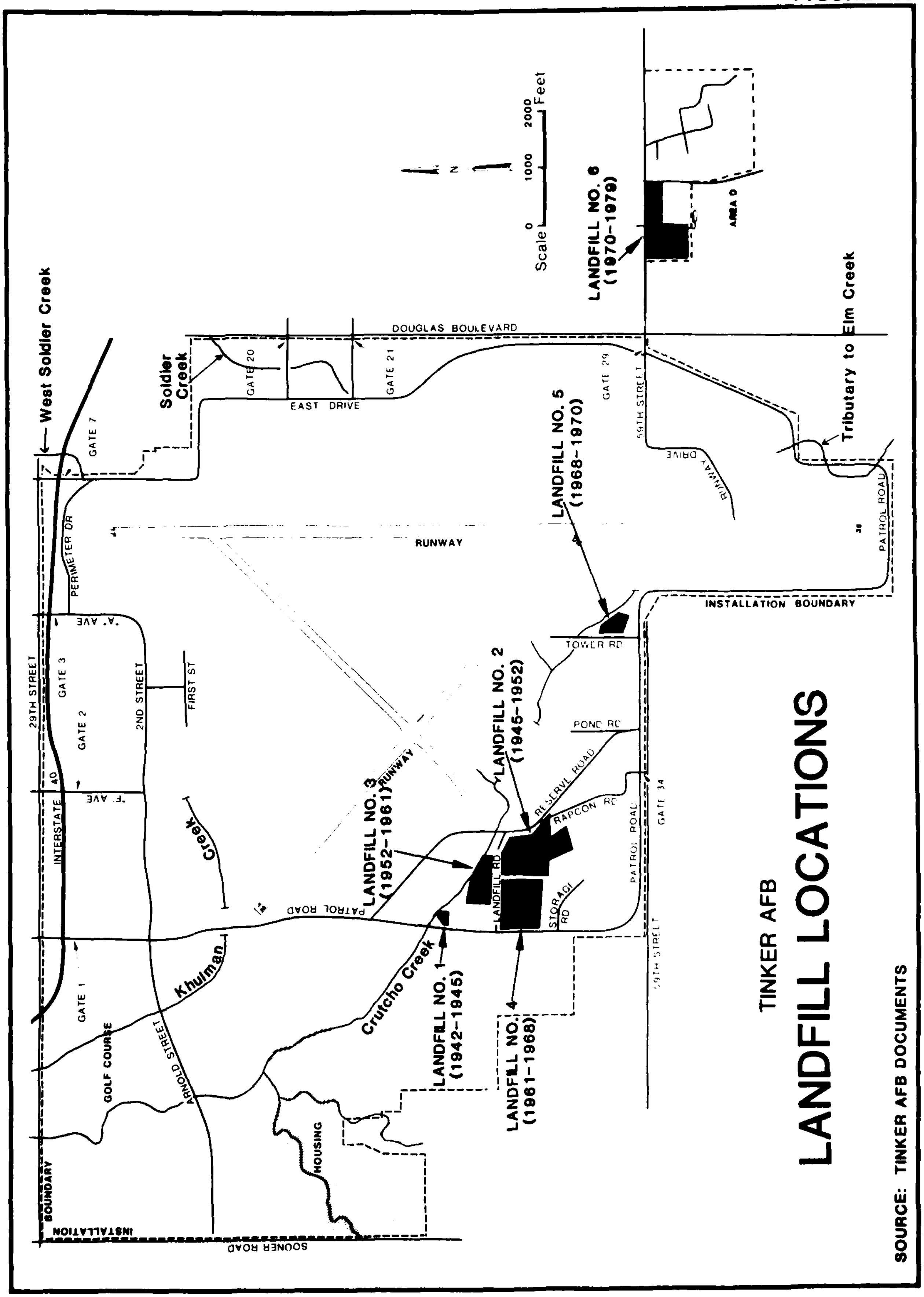
Landfill No. 1 is a small area, approximately 1 acre in size, south of Crutcho Creek along Air Depot Boulevard (as shown on Figure 4.6). This landfill was used from the formation of Tinker AFB in 1942 until 1945. Primarily general refuse from the base was disposed in the landfill, although the site may also have received waste solids from the

TABLE 4.3

TINKER AIR FORCE BASE SIGNIFICANT SPILLS, 1978-1981

Date	Location	Liquid Spills	Quantity Spilled	Comments
November 28, 1978	Facility 273	JP-4	1,200 gallons	Contained in dike and recovered
August 3, 1979	Building 3001	Acid scale conditioner	1,100 gallons	Neutralized
January 29, 1980	Building 486 (Hydrant System)	JP-4	1,500 gallons	No environmental damage
March 30, 1981	Building 486 (Hydrant System)	JP-4	2,500 gallons	No environmental damage

Source: Tinker AFB documents and employee interviews



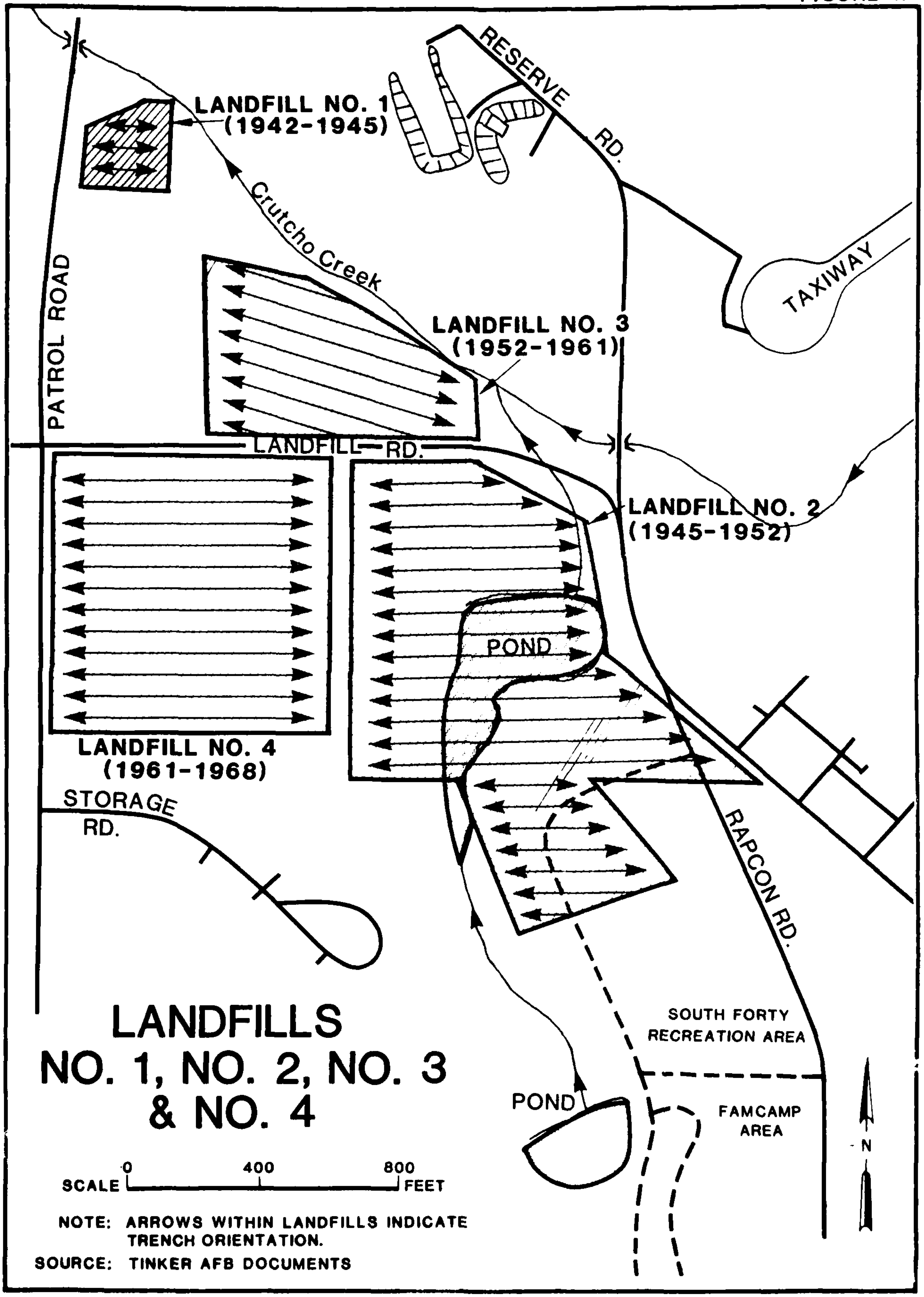
TINKER AFB
LANDFILL LOCATIONS

SOURCE: TINKER AFB DOCUMENTS

TABLE 4.4

SUMMARY OF LANDFILLS AT TINKER AIR FORCE BASE

Landfill	Period of Operation	Approximate Area (Acres)	Types of Wastes	Estimate Quantity (YD^3)	Method of Operation	Closure Status	Geological Setting	Surface Drainage	Comments
1	1942-1945	1.2	General Refuse	30,000	Burning, Trench	Closed, covered with earth, vegetation	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	Some water ponding due to differential settling in trenches
2	1945-1952	20	General refuse, probably some industrial waste	500,000	Trench	Closed, covered with earth, vegetation	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	A large pond is present above the landfill
3	1952-1961	8	General refuse, probably some industrial waste	200,000	Trench	Closed, covered with earth	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	Now used as storage area for hardfill and dirt
4	1961-1968	16	General refuse, probably some industrial waste, and POL sludges	400,000	Trench	Closed, covered with earth, partial vegetation	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	Leachate visible along westside of landfill. Past leachate samples show high mercury and phenols
5	1968-1970	3	General Refuse, probably some industrial waste	75,000	Trench	Closed, covered with earth, vegetation	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	Some leachate visible along side of landfill near creek
6	1970-1979	11	General Refuse, probably some industrial waste, and industrial waste treatment sludge	500,000	Trench	Closed, covered with earth, partial vegetation	Terrace; sand, silt, clays	To Soldier Creek	Covered and graded. No waste visible.



LANDFILLS NO. 1, NO. 2, NO. 3 & NO. 4

NOTE: ARROWS WITHIN LANDFILLS INDICATE TRENCH ORIENTATION.

SOURCE: TINKER AFB DOCUMENTS

domestic wastewater treatment plant. Refuse was disposed in trenches running east-west, and was typically burned to reduce volume. The trenches extended to a depth of 10 to 25 feet, through a 6 to 8 foot clay layer into a sand/rock zone. Landfill No. 1 is well covered and shows no exposure of the disposal cells; however, settlement in the trenches has resulted in surface depressions where water collects from rainfalls. This water evaporates or percolates through the landfill.

Landfill No. 2

After closure of landfill No. 1, landfill No. 2 was opened south of Landfill Road and west of Reserve Road (Figure 4.6). This landfill was utilized from 1945 until its closure in 1952. Approximately 20 acres were filled during this time period. Although most of the waste disposed of consisted of general refuse from the base, small quantities of paints and solvents were also buried. The waste was disposed of in trenches approximately 20 feet in depth and 35 to 40 feet wide, in an east-west orientation. The refuse was covered daily with several inches of excavated material, and completed trenches were covered with 3 to 4 feet of material.

Landfill No. 2 is well covered and vegetated with grasses and shows no erosion or exposure of landfill material. Several surface depressions with collected rain water caused by material settlement in the trenches are evident on the landfill. A pond, several acres in area, is also located on landfill No. 2. The pond was constructed in the mid-1960's either partly on top or adjacent to the landfill area. From the air, the outlines of trenches can be seen along the boundary of the pond where the water level is high enough to inundate portions of the trenches. Overflow from the pond enters the upper reaches of Crutcho Creek. It is presently unknown to what extent the pond waters percolate through the landfilled material.

Landfill No. 3

During the time period 1952-1961, wastes were disposed of in an eight acre area designated as landfill No.3. This area is located adjacent to landfill No. 2 north of Landfill Road and south of Crutcho Creek (Figure 4.6). The type of waste disposed of and disposal methods were similar to previous landfills. The landfilled material consisted primarily of general refuse, but did include paint buckets, insecticide cans, and empty barrels. A number of low-level radioactive vacuum tubes were also disposed of at this site. Landfill material were disposed of in trenches running the length of the landfill. Trenches were approximately 25 feet deep, and extended through a surface clay layer into a sand/rock layer. The refuse was covered daily, and a final cover of 3 to 4 feet of excavated material was placed on completed trenches.

Additional radioactive material was reported to have been disposed of in a deep pit adjacent to the northwest corner of landfill No. 3. The area was formerly posted with radioactivity warning signs, which have been destroyed. Radioactive burial is discussed in greater detail later in a subsection of this chapter.

Landfill No. 3 shows no evidence of erosion along the creek or elsewhere around the landfill. At present, additional dirt and hardfill are being stored on top of the landfill. This practice has been in effect for approximately 5 years.

Landfill No. 4

After closure of the landfill No. 3, a 16-acre site south of Landfill Road between landfill No. 2 and Air Depot Boulevard was utilized for refuse disposal and designated landfill No. 4 (Figure 4.6). Disposal practices were essentially the same as previous landfills, with a daily cover of 3 to 6 inches of compacted excavated material applied to the refuse and a final cover of several feet of soil used for completed trenches. The landfill was closed in 1968.

Surface leachate and associated gases have been observed along the west slope of the landfill along Air Depot Boulevard on several occasions since closure. A major problem with leachate from the west bank of landfill No. 4 occurred during 1979. Unusually heavy rainfall occurred during that year. Leachate occurred in a drainage ditch eventually leading to Crutcho Creek. Leachate and drainage ditch wastewater samples analysis data, shown in Table 4.5, indicated high concentrations of COD, oil and grease, phenols, and heavy metals. Unusually high concentrations of mercury (Hg) were also found in the leachate and drainage ditch samples, indicating that significant hazardous wastes quantities may be present in landfill No. 4.

Although the landfill area was covered up with a layer of top soil, small discharges of leachate are still observeable along the west and

TABLE 4.5

1979 ANALYSIS OF DRAINAGE CREEK AND LEACHATE FROM LANDFILL NO. 4

Parameter	Leachate Conc. (mg/l)	Drainage Creek Conc. (mg/l)
COD	29,000	910
Oil and Grease	400	76
Phenols	9.6	1.2
Ba	8.0	24.0
Fe	24.0	21.0
Mn	9.6	9.8
Hg	5.3	7.2
Ni	1.1	0.65
Zn	11.0	9.8

Source: Tinker AFB BESD Files

north banks of landfill No. 4. Surface runoff from these areas, including leachate, enters the drainage ditch and eventually enters Crutcho Creek.

Landfill No. 5

Landfill No. 5 located north of Patrol Road and east of Tower Road, (Figure 4.7) was used during the period 1968-1970. The disposal practices and types of wastes were the same as at Landfill No. 4. The three acre site is well covered and no waste material is exposed; however, waste compaction in the trenches has resulted in surface depressions which collect and hold rain water. A small area of seepage is noticeable on the north eastern edge of the landfill adjacent to West Crutcho Creek.

Landfill No. 6

Landfill No. 6 was used for the disposal of refuse from 1970 to 1979. This landfill, shown on Figure 4.8. is located adjacent to Area "D" approximately 1/2 mile east of Tinker AFB along S.E. 59th Street on land leased from Oklahoma City. Although 40 acres are available at the site, only about 20 acres on the western half of the landfill were used prior to the closing of the site during 1979. Base refuse since that time has been disposed of off-site by private contractor.

Materials disposed in landfill No. 6 consisted primarily of general refuse with small quantities of industrial waste materials such as paint buckets, insecticide cans, etc. Industrial wastewater treatment plant sludge was also intermittently disposed of in this landfill. The refuse was covered daily with 6 to 8 inches of compacted soil, and several feet of compacted cover was used as a final trench covering. Highly permeable river sand was used for daily cover for several years, although other areas had a cover of excavated clay and sand/rock. After closure, the site was revegetated with grasses. Field reconnaissance of the site indicated moderate surface erosion and no observed leachate.

Waste Disposal Pits

Prior to the establishment of an industrial wastewater collection and treatment system, some of the industrial wastes were disposed of in large, open pits. Two waste disposal pit areas, shown on Figure 4.9, were located on the east side of the base south of the aircraft

FIGURE 4.7

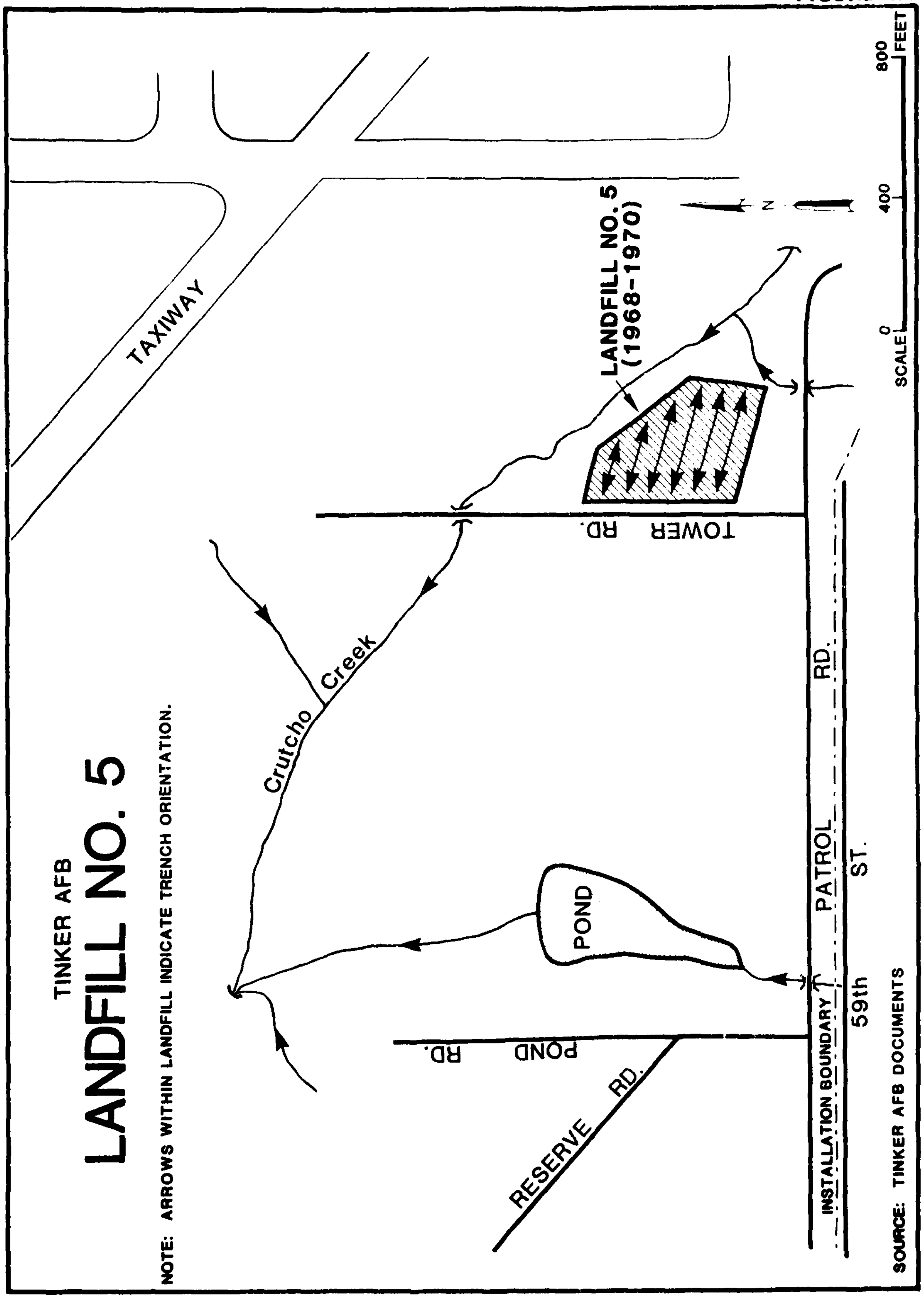
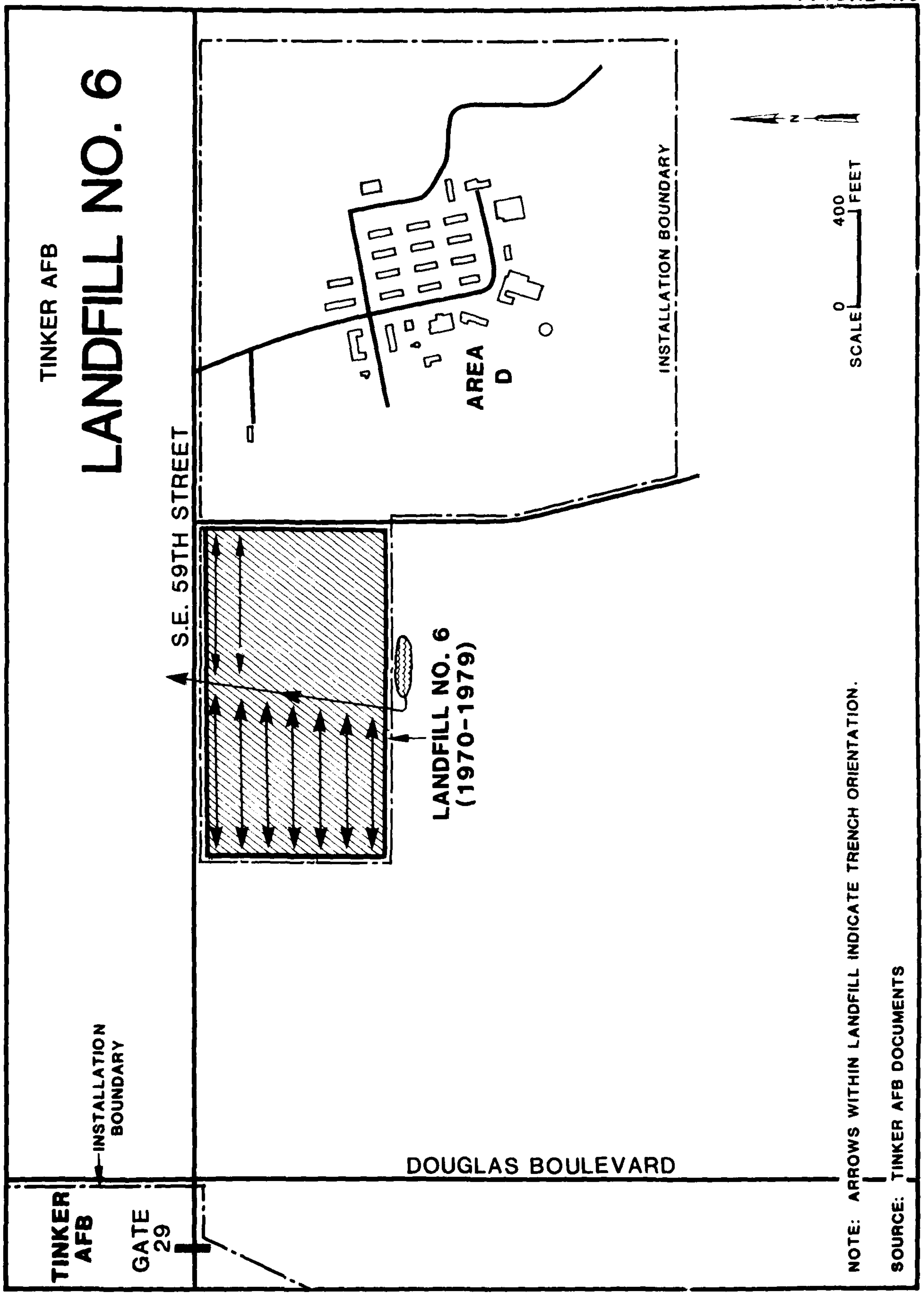
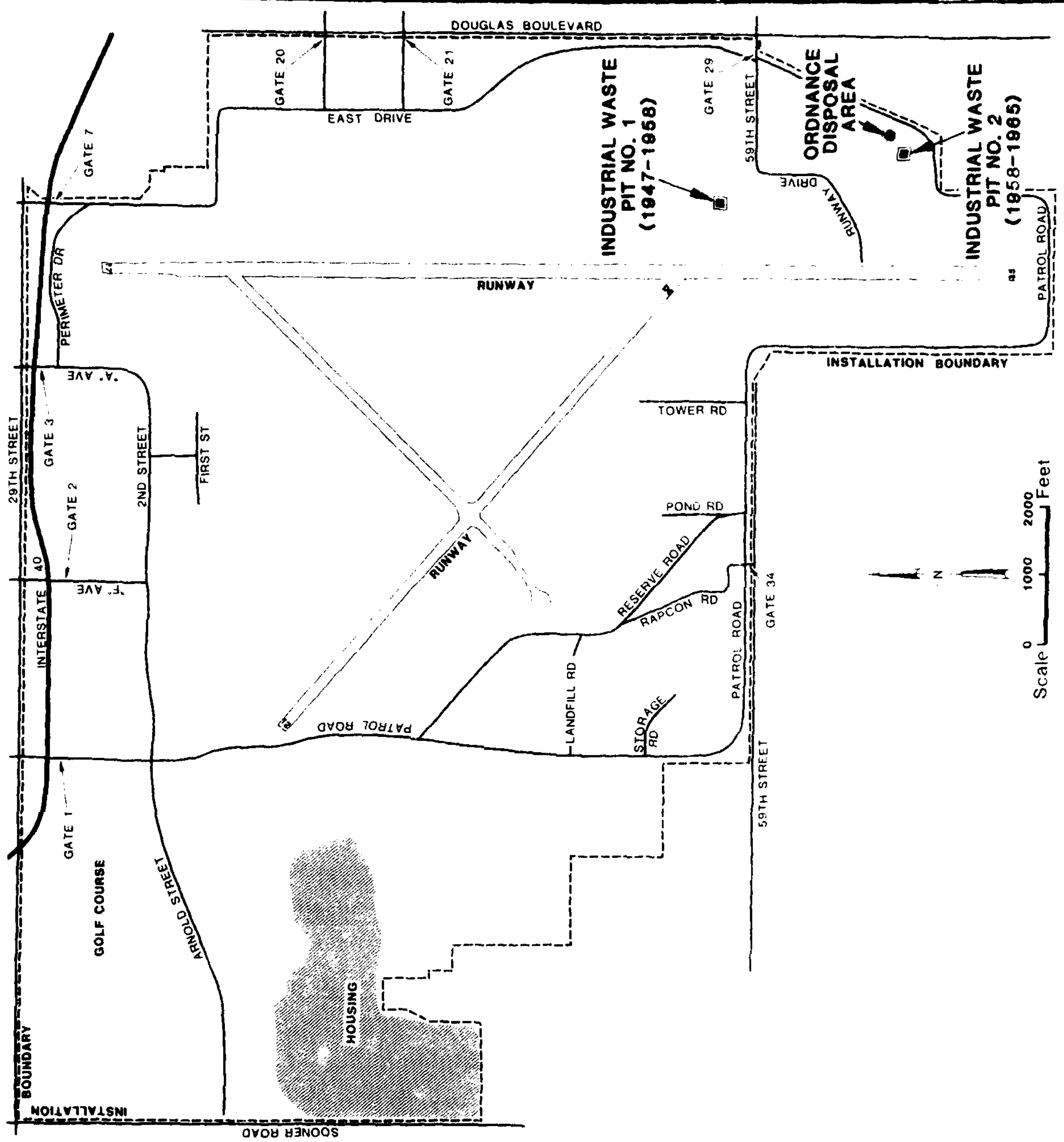

TINKER AFB
LANDFILL NO. 5
NOTE: ARROWS WITHIN LANDFILL INDICATE TRENCH ORIENTATION.
TAXIWAY
Crutcho Creek
POND
LANDFILL NO. 5
(1968-1970)
TOWER RD.
POND RD.
RESERVE RD.
PATROL RD.
59th ST.
INSTALLATION BOUNDARY
N
SCALE
0
400
800
FEET
SOURCE: TINKER AFB DOCUMENTS

FIGURE 4.8


TINKER AFB
LANDFILL NO. 6
S.E. 59TH STREET
INSTALLATION BOUNDARY
AREA D
SCALE 0 400 FEET
N
LANDFILL NO. 6 (1970-1979)
INSTALLATION BOUNDARY
DOUGLAS BOULEVARD
TINKER AFB
GATE 29
NOTE: ARROWS WITHIN LANDFILL INDICATE TRENCH ORIENTATION.
SOURCE: TINKER AFB DOCUMENTS



TINKER AFB

INDUSTRIAL WASTE PITS and ORDNANCE DISPOSAL AREA

SOURCE: TINKER AFB DOCUMENTS

maintenance area. The pits were used for the disposal of industrial wastes between 1947 and 1965.

Industrial waste pit No. 1 was located southwest of Building 2121, as shown in Figure 4.10. Waste disposal occurred during the period 1947-1958. During the base records search, no written information was located to indicate what was placed in the pit, although interviews with several base personnel indicated large quantities of waste oils, contaminated fuels, chromates, phenols, cyanides, and waste acids and bases generated by plating and maintenance activities were disposed in this facility. The petroleum based contents of the pit may have been burned routinely.

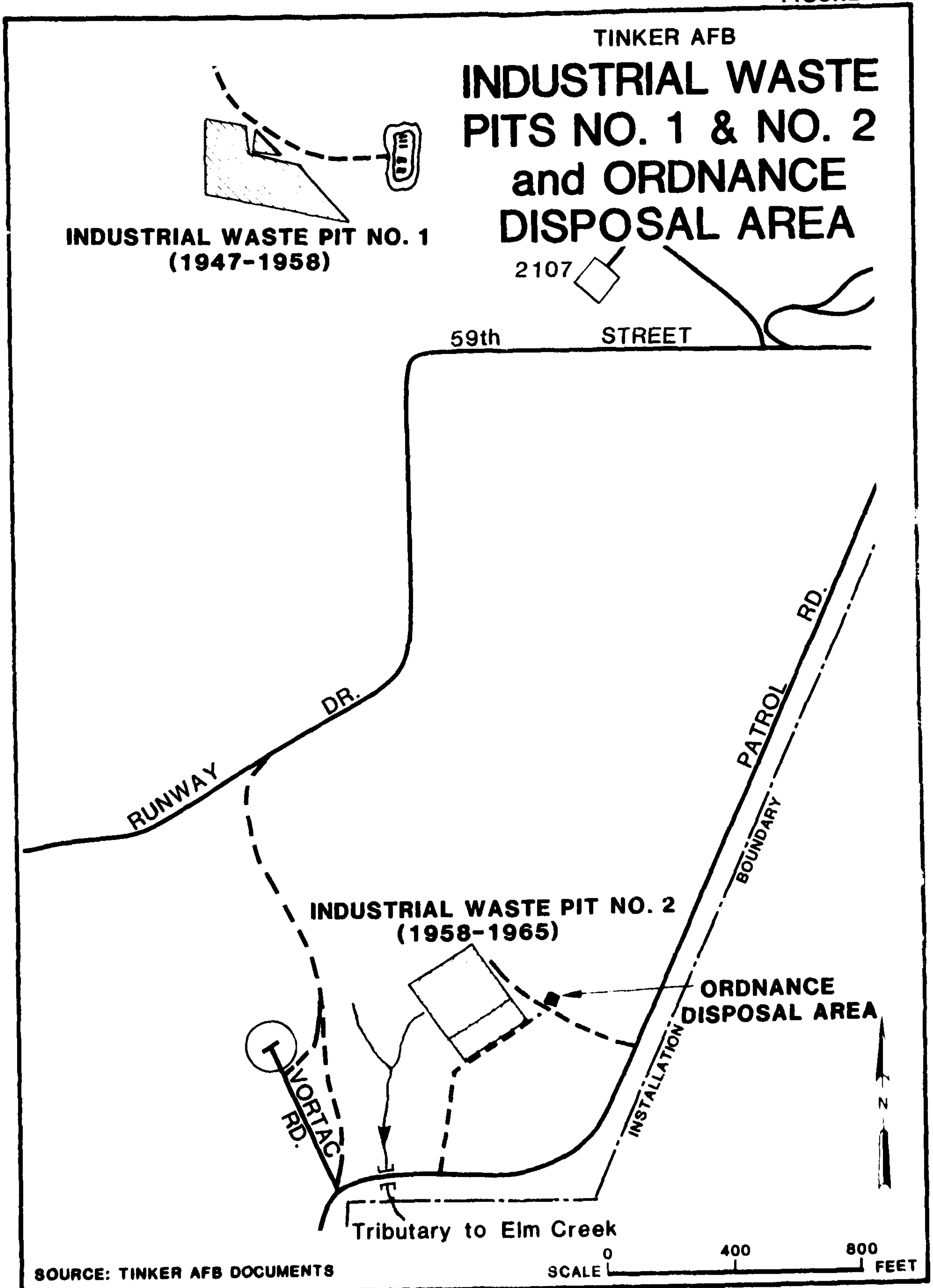
The pit was unlined, and unknown quantities of wastes may have migrated through the soil beneath and around the pit. Surface runoff from the No. 1 pit, if any, would have entered the headwaters of Crutcho Creek. Waste residue may still be present at the site, as there is no evidence that the pit was dredged to remove residual material when the pit was covered and graded over in 1958. There are no visible surface features to indicate exactly where pit No. 1 was located. However, aerial photographs obtained from the base historian and shown in Appendix E show the pit location during operation.

In 1958, industrial waste pit No. 1 was abandoned and a second pit was constructed on a hill between Patrol Road and the airfield runway (Figure 4.10). Industrial waste pit No. 2 also received hazardous wastes such as waste oils, cyanides, chromates, phenols, solvents, and waste acids and alkalies. During the records search, no information was found concerning the construction of the pit. If the pit were unlined, hazardous wastes may have migrated beyond the original pit area. Aerial photographs reveal that the waste pit may have an overflow discharge which drained into Elm Creek. Disposal of hazardous wastes in the pit continued until the early 1960's, and the pit was filled and graded in 1965. There was no information indicating that the waste pit was dredged before it was covered. A photograph of industrial waste pit No. 2 is also shown in Appendix E.

Radioactive Waste Disposal Sites

Radioactive wastes are reported to have been disposed at four locations within Tinker AFB. The burial sites identified as containing

FIGURE 4.10



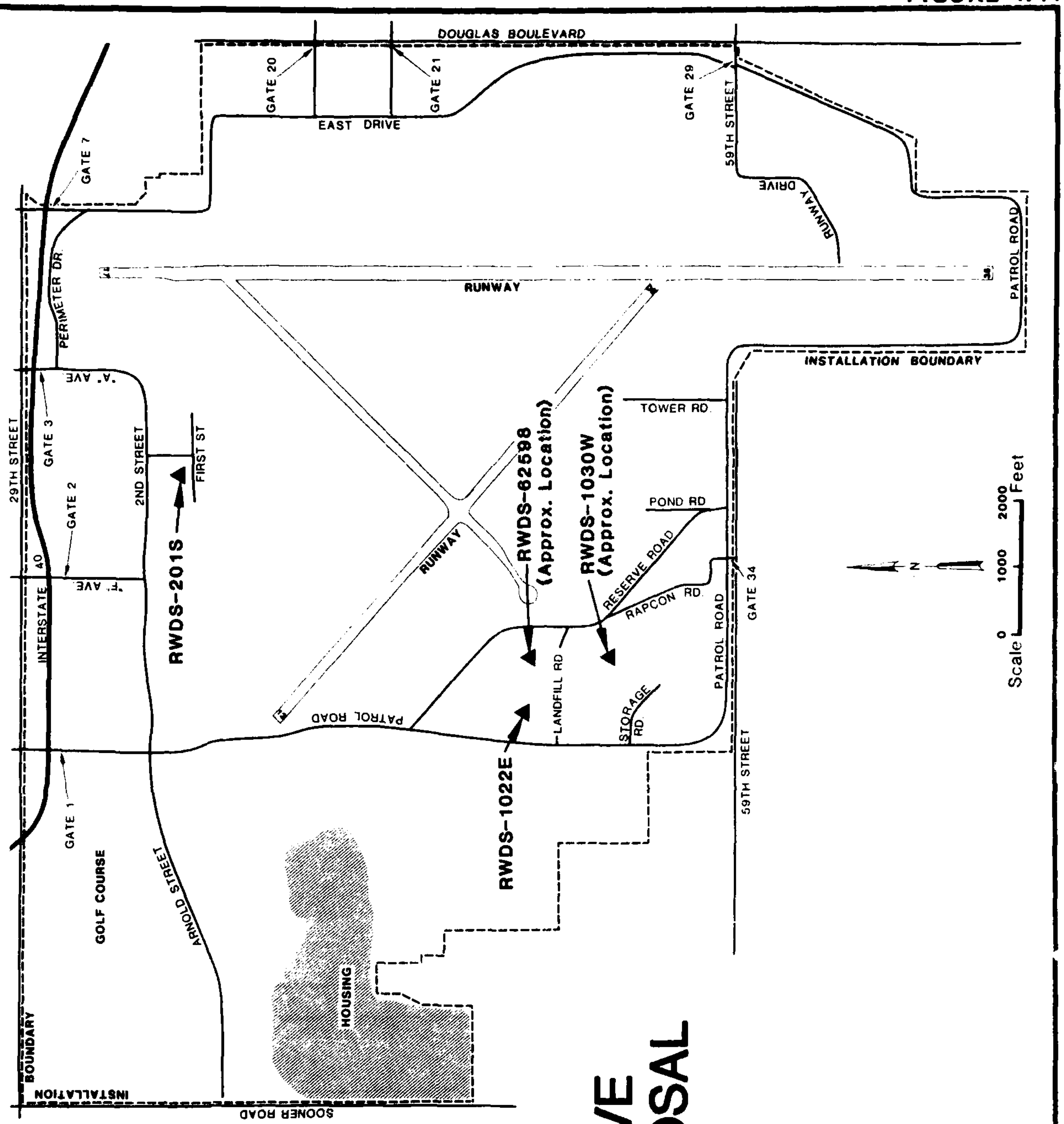
SOURCE: TINKER AFB DOCUMENTS

radioactive wastes are shown on Figure 4.11. A summary of information on each radioactive waste disposal site is contained in Table 4.6.

Radioactive Waste Disposal Site (RWDS) 201S is located adjacent to the overhead conveyor south of Building 201 as shown in Figure 4.12. The site is marked by a concrete post, although radiation warning signs are not posted. Very little information is available concerning radioactive waste disposal at this site. The burial area encompasses approximately 10 square feet and was used for the disposal of radium paint dials and radium paint solids. The dates of operation of this disposal site are not known, and the area is no longer used for disposal of radioactive wastes. No information is available concerning the construction of the disposal pit, depth of burial, or quantity of waste disposed. Radiological monitoring of the site by the Bioenvironmental Engineering Services Division in October 1981 indicated no radioactivity in excess of natural background levels.

A second radioactive waste disposal site, RWDS 62598, is located south of Facility 1025 and north of Crutcho Creek (Figure 4.13). A concrete post with attached radiation warning sign marks the general disposal area. The site contains a "lead still" made of sheet lead used to evaporate methyl ethyl ketone (MEK) or acetone for reuse. The MEK and acetone were contaminated with radium paint from cleaning radium dials. After use, a residue of radium paint solids remained in the still. Following a period of usage, the lead still became radioactive due to the accumulation of solids. In the early 1950's, the lead still was reportedly buried in the general area marked by the concrete post. The depth of burial is not known. One Air Force document states the waste may later have been removed; however, no conclusive evidence exists for either the presence or absence of the waste. Recent radiological monitoring has identified no area of increased radioactivity near the site.

Another radioactive waste disposal site, RWDS 1022E, is located adjacent to the northwest corner of landfill No. 3 south of West Crutcho Creek (Figure 4.13). During the mid-1950's approximately 8 to 10 containers of radioactive material from Building 230 were disposed of at the site. The material was placed in a hole approximately 30 feet deep



TINKER AFB

RADIOACTIVE WASTE DISPOSAL SITES

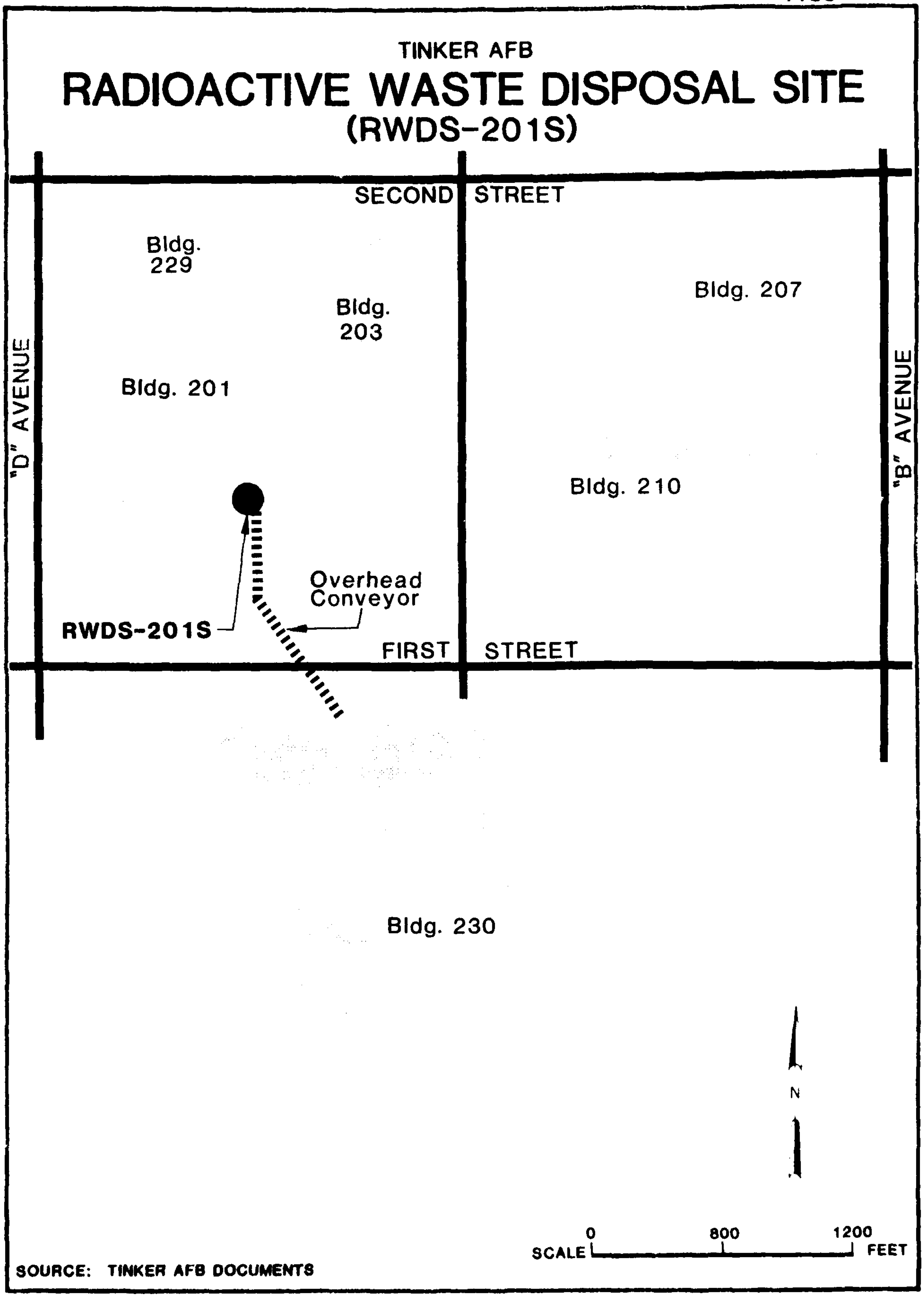
SOURCE: TINKER AFB DOCUMENTS

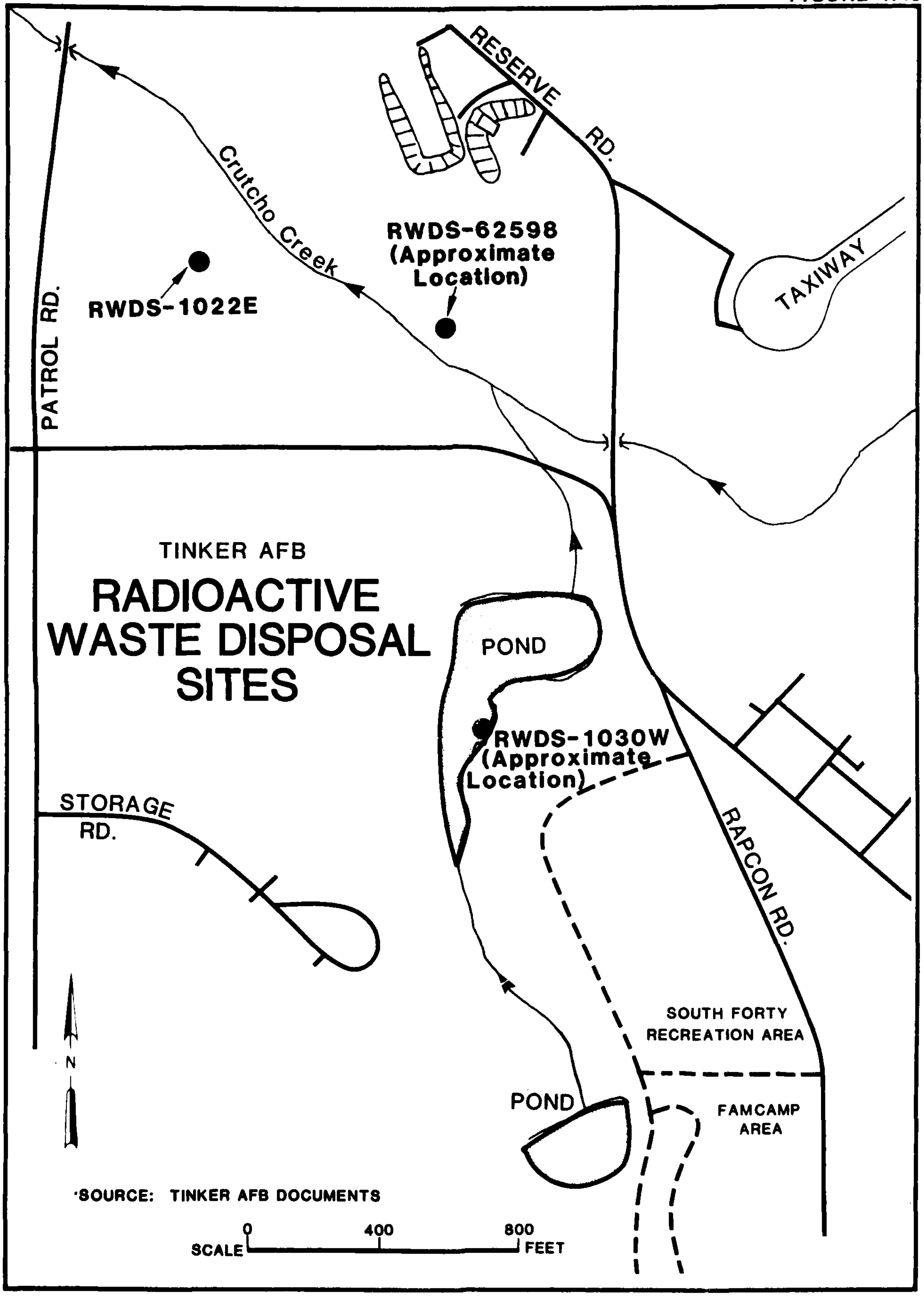
TABLE 4.6

SUMMARY OF RADIOACTIVE WASTE DISPOSAL SITES

Landfill	Period of Operation	Approximate Area (Acres)	Types of Wastes	Estimate Quantity (YD^3)	Method of Operation	Closure Status	Geological Setting	Surface Drainage	Comments
RWDS 62598	Unknown	<0.1	Radioactive "lead still" used for distilling acetone	<10	Pit	Closed (Possibly removed)	Fine-grained sandstone; shale and mudstone	To Khulman Creek	Buried lead still behind Bldg 1025 and creek. Exact location not known.
RWDS 201S	Unknown	<0.1	Low-level radioactive radium paint solids	<10	Pit	Closed	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	Radium paint solids buried in pit. Concrete cap.
RWDS 1022E	Late 1950's	<0.1	Low-level radioactive wastes	<10	Pit	Closed	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	8 to 10 kegs of low-level radioactive material buried.
RWDS 1030W	Prior to 1955	<0.1	Low-level radioactive wastes.	<10	Pit	Closed (Possibly Removed)	Fine-grained sandstone; shale and mudstone	To Crutcho Creek	Rags and acetone solutions which contained radium

FIGURE 4.12


TINKER AFB
RADIOACTIVE WASTE DISPOSAL SITE
(RWDS-201S)
SECOND STREET
Bldg. 229
Bldg. 203
Bldg. 207
"D" AVENUE
"B" AVENUE
Bldg. 201
Bldg. 210
Overhead Conveyor
RWDS-201S
FIRST STREET
Bldg. 230
N
0
800
1200
SCALE
FEET
SOURCE: TINKER AFB DOCUMENTS


RESERVE RD.
Crutcho Creek
RWDS-62598
(Approximate
Location)
TAXIWAY
RWDS-1022E
PATROL RD.
TINKER AFB
RADIOACTIVE
WASTE DISPOSAL
SITES
POND
RWDS-1030W
(Approximate
Location)
STORAGE
RD.
RAPCON RD.
SOUTH FORTY
RECREATION AREA
N
POND
FAMCAMP
AREA
SOURCE: TINKER AFB DOCUMENTS
0
400
800
SCALE
FEET

located next to landfill No. 3, which was operative during the period 1952-1961. The area was marked with radiation warning signs, although none are now present. The area was surveyed with beta/gamma radioactivity detector equipment during November 1981. Radiation levels of 0.03 mr/hr above a background of 0.02 mr/hr were detected; indicating radioactive materials are present, but do not result in radioactivity levels hazardous to human health.

The fourth radioactive waste burial site was identified as being located 1200 feet west and 550 feet north of Building 1030. The site is under water in one of the base's fishing ponds. The area purportedly contained radium dial wastes. A verbal report referenced in an Air Force document asserts that all radioactive wastes were removed in 1955, when the sanitary landfill was established.

Industrial Wastewater Treatment Facilities

Treatment of industrial liquid waste streams began in 1963 and was located in the northeast corner of the base near Gate 19. The treatment facility has discharged treated wastewater to Soldier Creek. The waste facilities were designed to treat approximately 290,000 gallons per day of primarily waste electroplating solutions. In 1969, additional industrial sewer lines were installed to collect dilute streams of electroplating cleaning, and other maintenance area waste streams for treatment. Major improvements in the treatment system were completed in 1971 which increased the design capacity to 1.8 million gallons per day (MGD). Major concentrated streams of electroplating and cleaning solutions from the Directorate of Maintenance were treated by the upgraded facility.

The wastewater treatment units included batch processing of phenols, cyanides, and chrome solutions. Oil/water separators, equalization basins, chemical reduction units, solids contact clarifiers, biological treatment, and chlorine contact chambers are utilized.

Sludge from the industrial waste treatment facility has been disposed of off-base by a contract service. The sludge was occasionally disposed in base landfills through 1979.

Sanitary Wastewater Treatment Facilities

Domestic sewage has been treated on-base since 1942 by an actived sludge system and a single stage trickling filter system. The activated sludge system served the north central and west base areas until the early 1970's. This system discharged treated effluent into a tributary to Crutcho Creek. This system is located on Patrol Road at Reserve Road and is now used for storage of pesticide chemical and drummed hazardous waste. This sewage treatment system may have received infrequent batches of oil and grease for treatment from the aircraft maintenance areas located in the north central base area. Domestic sewage from the north central and west base areas presently are connected to the Oklahoma City sanitary sewer system.

The single stage trickling filter treatment facility is located adjacent to the industrial waste treatment facility. This system treats domestic sewage from the east base area. The design capacity of the plant is 0.9 MGD, however normal discharge flow is estimated to be 60 percent of design flow. This treatment facility treated quantities of industrial waste streams from the early 1960's to the early 1970's prior and during the expansion of the industrial waste treatment facility. However, no process unit design changes were initiated for treatment of industrial wastes.

Storm Sewer System

Evidence of hazardous liquid waste disposal in the base storm sewer systems was obtained primarily through a report prepared by USAF Occupational and Environmental Health Laboratory (OEHL) in April 1980 (Huang, 1980). This report summarized water quality sampling data collected and analyzed during dry weather conditions in the storm sewer systems around Buildings 3001, 3102, 3105, 3108, 3705 and 3703. High concentration of phenols, chromium and zinc were indicated by the sample data in the storm sewer serving Building 3703 (engine test cells). No potential source for these compounds were determined in the report. The storm system discharges to Soldier Creek.

Ordnance Disposal

Ordnance disposal was conducted on base between the early 1960's and 1972 by a detachment of the 2701 EOD Squadron. The ordnance disposal area was located at the southeast end of the North-South Runway (Figure 4.10) and comprised a burn pit with an adjacent igloo-shaped protective bunker. Ordnance burned during this period consisted of outdated small arms munitions, blasting caps, flares, pyrotechnics and egress items. The frequency of burning operations was less than once per month. Since 1972, all ordnance disposal required by Tinker AFB has been performed at nearby military installations.

Defense Property Disposal Office

The Defense Property Disposal Office (DPDO) has handled the contracting for collection and transportation of resalable waste petroleum products. These products include: waste jet fuel, waste oils, waste synthetic oils and chlorinated hydrocarbon solvents. The contracts are granted by DPDO on a bid basis. DPDO is presently finalizing an agreement with CES concerning collection, transportation and disposal of all chemical waste and nonresalable petroleum product waste materials for the base. Eleven transformers believed to contain PCB materials are currently in storage within the DPDO area (Building 3770).

EVALUATION OF PAST DISPOSAL ACTIVITIES AND FACILITIES

The review of past operation and maintenance functions and past waste management practices at Tinker AFB has resulted in the identification of 14 sites containing hazardous waste materials and having the potential for migration of contamination. Other sites were reviewed and eliminated from further evaluation based on the logic presented in the decision tree shown in Figure 4.1.

The 14 sites have been assessed using a hazardous assessment rating methodology (HARM), which takes into account characteristics of potential receptors, waste characteristics, pathways for migration, and specific characteristics of the site related to waste management practices. The details of the rating procedures are presented in Appendix G and the results of the assessment are summarized in Table 4.7. The HARM system is designed to indicate the relative need for follow-on action. The information presented in Table 4.7 is intended as a guide for assigning priorities for further evaluation of the Tinker AFB disposal areas (Chapter 5, Conclusions and Chapter 6, Recommendations). The rating forms for the individual waste disposal sites on Tinker AFB are presented in Appendix H. Photographs of some of the key disposal sites are contained in Appendix E.

TABLE 4.7

SUMMARY OF HARM SCORES FOR POTENTIAL CONTAMINATION SOURCES

Rank	Site Name	Receptor Subscore	Waste Characteristic Subscore	Pathways Subscore	Waste Management Factor	Overall Total Score
1	Landfill No. 4	57	53	100	1.0	70
2	Industrial Waste Pit No. 2	57	100	46	1.0	68
3	Landfill No. 2	56	40	100	1.0	65
4	Industrial Waste Pit No. 1	54	100	28	1.0	61
5	Landfill No. 3	54	60	65	1.0	60
6	RWDS 1030W	56	20	100	1.0	59
7	Landfill No. 6	59	45	65	1.0	56
8	Fire Training Area No. 1	54	70	42	1.0	55
9	Landfill No. 5	57	40	57	1.0	51
10	RWDS 1022E	54	50	42	1.0	49
11	Fire Training Area No. 2	54	36	50	1.0	47
12	Landfill No. 1	54	40	42	1.0	45
13	RWDS 62598	54	15	42	1.0	37
14	RWDS 201S	53	25	28	1.0	35

CHAPTER 5

CONCLUSIONS

CHAPTER 5

CONCLUSIONS

The goal of the IRP Phase I study is to identify sites where there is the potential for environmental contamination resulting from past waste disposal practices and to assess the probability of contaminant migration from these sites. The conclusions given below are based on the assessment of the information collected from the project team's field inspection, review of records and files, review of the environmental setting, and interviews with base personnel, past employees and state and local government employees. Table 5.1 contains a list of the potential contamination sources identified at Tinker AFB and a summary of HARM scores for those sites.

1) Landfill No. 4 has a high potential for migation of contaminants. This landfill was utilized from 1961 to 1968 and is now a closed site. Leachate has been observed along the west and north banks of Landfill No. 4 despite top soil cover. Results of a leachate sample analysis has indicated the presence of mercury, phenols, and oil and grease. Landfill No. 4 is located 1,500 feet from a drinking water well and 1,300 feet from the base boundary. The distance to ground water is approximately 250 feet and the regional geology information indicates moderately permeable material between the bottom of the landfill and the water level in the aquifer. The landfill received a HARM score of 70.

2) Industrial waste pit No. 2 has a high potential for migration of contaminants due to the types and estimated quantities of hazardous wastes disposed at this location. Waste pit No. 2 is 1,500 feet from the nearest drinking water well and is 1,500 feet from the base boundary. The estimated depth to ground water is 250 feet. The pit was operated from 1958 to 1965 and did not have an impermeable liner. Waste pit No. 2 received a HARM score of 68.

3) Landfill No. 2 has a high potential for contaminant migration. This landfill was operated from 1945 through 1952 and received general refuse from the base and small quantities of industrial waste.

TABLE 5.1

PRIORITY RANKING OF POTENTIAL CONTAMINATION SOURCES

TINKER AFB

Rank	Site Name	Date of Operation or Occurrence	Overall Total Score
1	Landfill No. 4	1961-1968	70
2	Industrial Waste Pit No. 2	1958-1965	68
3	Landfill No. 2	1945-1952	65
4	Industrial Waste Pit No. 1	1947-1958	61
5	Landfill No. 3	1952-1961	60
6	RWDS 1030W	Prior to 1955	59
7	Landfill No. 6	1970-1979	56
8	Fire Training Area No. 1	1950-1962	55
9	Landfill No. 5	1968-1970	51
10	RWDS 1022E	Mid 1950's	49
11	Fire Training Area No. 2	1962-1966	47
12	Landfill No. 1	1942-1945	45
13	RWDS 62598	Early 1950's	37
14	RWDS 201S	Unknown	35

Note: This ranking was performed according to the Hazardous Assessment Rating Methodology (HARM) described in Appendix G. Individual site rating forms are in Appendix H.

The site is closed and has a soil cover with vegetation. The trench areas have settled leaving small depressions in the surface. The southeast section of the site is now a park and recreation area with a small pond built over landfill material. The pond may be acting as a source of infiltration into the landfill. The HARM score for this site was 65.

4) Industrial waste pit No. 1 has a moderate potential for contaminant migration. This pit was used for disposal of industrial waste between 1947 and 1958. Waste pit No. 1 is 1,100 feet from the nearest drinking water well and 2,250 feet from the base boundary. The estimated depth to ground water is 250 feet. Waste pit No. 1 received a HARM score of 61.

5) Landfill No. 3 received general refuse and small amounts of industrial wastes from 1952 through 1961 and poses a moderate potential for contaminant migration. It is believed that some low level radioactive waste was buried by the northwest corner of this landfill. The site is closed with a soil cover and is being used to stockpile surplus fill dirt and rubble (hardfill). Crutcho Creek runs on the north edge of the landfill. The HARM score for Landfill No. 3 was 60.

6) Radioactive waste disposal site (RWDS) 1030W has a moderate potential for contaminant migration primarily because a pond has been constructed over the burial site. The waste is not very toxic (low level radioactive contaminated material) and there may only be a small quantity present. Base reports indicate the waste may have been removed in 1955 during construction of the landfill. The site received a HARM score of 59.

7) Landfill No. 6 poses a moderate potential for migration of contaminants. Landfill No. 6 was operated from 1970 though 1979 and received general refuse and small quantities of miscellaneous industrial wastes and dewatered sludge from the industrial waste treatment plant. The landfill is now closed and has a soil cover and vegetation over most of the surface. No significant erosion was observed at this landfill. The HARM score for Landfill No. 6 was 56.

8) Fire training area No. 1 has a moderate potential for migration of contaminants. Training exercises at area No. 1 may have utilized waste solvents, as well as waste oils and fuels. This pit was unlined during the period of operation (1950 till 1962). Fire training area

No. 1 is 700 feet from the nearest drinking water well and 2,100 feet from the base boundary. This area is about 100 feet from Crutcho Creek. Fire training area No. 1 received a HARM score of 55.

9) Landfill No. 5 has a moderate potential for contaminant migration. This landfill was operated from 1968 through 1970 and received primarily general refuse from the base. Small quantities of chemical and miscellaneous industrial wastes are believed to have been disposed of in this landfill. The site is closed and has a soil cover with vegetation; however, settling in the trench areas has created depressions which retain rainwater runoff. Some seepage streams were observed coming from the base of the landfill on the northeast side. This landfill is adjacent to a drinking water well, a surface stream, and close to the base boundary. The HARM score for Landfill No. 5 was 51.

10) RWDS 1022E has a low potential for contaminant migration. The site was used during the mid-1950's to dispose several containers of low-level radioactive material. Recent radiological surveys by base personnel indicated no radioactivity levels which are hazardous to human health. RWDS 1022E received a HARM score of 49.

11) Fire training area No. 2 has a low potential for contaminant migration. This site was used infrequently as a temporary fire training site from 1962 to 1966. This site received a HARM score of 47.

12) Landfill No. 1 poses a low potential for migration of contaminants and received a HARM score of 45. This landfill is closed and covered. The general refuse disposed in this landfill was burned to reduce volume. Only small amounts of chemicals and industrial wastes were suspected of being disposed in this landfill.

13) RWDS 62598 has a low potential for contaminant migration. The site contains low-level radioactive materials. An Air Force document indicate that the material may have been removed. Recent radiological monitoring has identified no area of increased radioactivity near the site. RWDS 62598 received a HARM score of 37.

14) RWDS 201S also has a low potential for contaminant migration. The site was used for the burial of low-level radioactive contaminated material. Recent radiological monitoring has identified no area of increased radioactivity near the site. RWDS 201S received a HARM score of 35.

15) The surface drainage systems on-base have been sources of contaminant migration since 1942 when the base operation began. This is confirmed by surface water quality data from the U.S. Geological Survey, R.H. Frank, Jr. (1969), and the base Bioenvironmental Engineering monitoring program. The quantity of contaminants discharged from the base was reduced significantly in the 1960's and again in the 1970's when industrial waste treatment facilities were constructed. A sediment sample collected in East Soldier Creek and a soil sample collected from Crutcho Creek were analyzed in July 1981, by the Oklahoma Water Resources Board and indicated high concentrations of chromium and nickel (East Soldier Creek) and COD, oil and grease and total organic carbon (Crutcho Creek). Contaminants may migrate through sediment leaching into the local surface waters and into the ground-water system.

CHAPTER 6

RECOMMENDATIONS

CHAPTER 6

RECOMMENDATIONS

To aid in the comparison of the 14 sites on Tinker AFB with those sites identified in the IRP at other Air Force Bases, a hazardous assessment rating methodology (HARM) was developed. Of primary concern at Tinker AFB are those sites with a high potential for contaminant migration and with HARM scores greater than 64. These sites require further investigation in Phase II. Sites of secondary concern are those with moderate potential for contaminant migration and have HARM scores from 50 to 64. Further investigation at these sites is recommended. No further monitoring is recommended for those sites with low potential for migration of contaminants (scores from 0 to 49) unless other data collected indicate a potential problem could exist at one of these sites.

The following recommendations are made to further assess the potential for contaminant migration from waste disposal areas at Tinker AFB. The recommended monitoring program for Phase II is summarized in Table 6.1.

1) Landfill No. 4 is considered to have a high potential for migration of contaminants and monitoring of the site is recommended. The strata under the landfill is believed to be moderately permeable and there may not be any shallow ground water except after heavy rainfall periods. Therefore geophysical monitoring is recommended to better define the geology under the landfill, define the landfill boundaries and identify any leachate plume. It is further recommended that lysimeters be installed on the north, south and west side of the landfill. The lysimeters should be installed at an angle to extend under the landfill. If water is detected then samples should be collected and analyzed for the parameters in List A, Table 6.2. It is also recommended that samples be collected from the existing ground-water monitoring wells, down-gradient and up-gradient of the landfill, and analyzed for

the parameters in List A, Table 6.2. If the existing up-gradient monitoring well continues to be dry then a new well should be installed to obtain a background sample. If any leachate is found discharging from the site, it too should be sampled and analyzed for the parameters in List A, Table 6.2.

2) Industrial Waste Pit No. 2 has a high potential for migration of contaminants and a sampling and analysis program at this site is recommended. The recommended monitoring includes collecting soil boring samples and conducting geophysical testing. Nine soil borings should be collected in the pit area and two soil boring outside the pit. The borings should be ten feet deep and soil samples taken at the surface, five feet, ten feet and at any waste interface encountered. Analyses should be performed on a water extraction and then analyzed for the parameters in List B, Table 6.2. A geophysical survey should be conducted to define the site boundaries and identify any leachate plume.

3) Landfill No. 2 has a high potential for contaminant migration and follow-on testing is recommended. The testing program as described for Landfill No. 4 (Item 1) is proposed for this site. It is further recommended that the pond be drained to reduce the potential for contaminant movement in the ground water.

4) Industrial Waste Pit No. 1 has a moderate potential for contaminant migration and follow-on testings as described for Industrial Waste Pit No. 2 (Item 2) is recommended.

5) Landfill No. 3 has a moderate potential for migration of contaminants. A follow-on testing prograr s described for Landfill No. 4 (Item 1) consisting of geophysical testing, construction and sampling of lysimeters, and sampling the existing ground-water monitoring wells is recommended for this site.

6) Radioactive Waste Disposal Site 1030W has a moderate potential for migration of contaminants and follow-on testing is recommended. Since this site is believed to be located in the pond over Landfill No. 2, it will be necessary for the pond to be drained before testing the site. Water samples should be collected from the discharge of the pond and analyzed for gross alpha and gross beta radiation levels. After the pond has been drained, the surface area around the burial site should be scanned for beta and gamma radiation levels.

7) Landfill No. 6 has a moderate potential for contaminant migration and follow-on testing is recommended. The test program should be similar to that proposed for Landfill No. 4 (Item 1).

8) Fire Training Area No. 1 is considered to have mod .ate potential for migration of contaminants and monitoring of this site is recommended. A monitoring program consisting of geophysical testing and collecting/analyzing soil boring samples the same as described for the Industrial Waste Pit No. 2 (Item 2) is recommended for this site.

9) Landfill No. 5 has a moderate potential for migration of contaminants. Follow-on testing similar to that proposed for Landfill No. 4 (Item 1) is recommended at this site.

10) Historical water quality data, interviews with base personnel, base records concerning waste disposal activities, fire training and wastewater discharge all substantiate that there is a significant potential for contamination of the stream sediments within the base and downstream of the base. It is recommended that the Air Force conduct a one-time comprehensive sediment sampling program on all the streams existing on the base which may have had the potential to become contaminated. The recommended locations for the sediment sampling is shown on Figure 6.1. A total of 24 stations were selected: ten on Crutcho Creek, two on tributaries flowing to Crutcho Creek from the housing area, three on Khulman Creek, one on West Soldier Creek, five on Soldier Creek, one on a small tributary to Elm Creek, one on the drainage ditch adjacent to Landfill No. 6, and one on a drainage ditch at the intersection of Pond Road., and Patrol Road. It is also recommended that the Air Force collect water samples at these same locations simultaneous to the sediment sampling. Table 6.2 contains a list of the parameters which are recommended for both the sediment and water sample analyses (List B).

11) The water level in the existing monitoring wells and the stream should be checked to determine if the stream is the source of the shallow aquifer water.

12) Water supply wells No. 6, 7, 16, 18, 22, 23, 24, 25, 27 and 28 shown in Figure 3.10 should be sampled and analyzed for the parameters in List A of Table 6.2.

TABLE 6.1

RECOMMENDED MONITORING PROGRAM FOR PHASE II - TINKER AFB

Site	Rating Score	Recommended Monitoring	Comments
Landfill No. 4	70	a) Conduct geophysical survey to identify site boundaries and define leachate plume (if present). b) Install three lysimeters around the site (one each on north, south and west side). The lysimeters should be installed at an angle to extend under the landfill. If water is detected, then samples should be collected and analyzed for the parameters in List A (Table 6.2). c) Measure water levels and collect samples from existing ground-water monitoring wells (down-gradient). Analyze samples for parameters in List A. One up-gradient sample should also be obtained. If a sample cannot be obtained from the existing background well (No. 11), then a new monitoring well may be needed to obtain an up-gradient well sample. d) Sample any leachate streams and analyze for parameters in List A.	Conducting the geophysical survey of Landfills Nos. 2, 3 and 4 jointly is advantageous because of their proximity to each other.
Industrial Waste Pit No. 2	68	a) Obtain soil borings in and around the waste pit (9 in the pit area and 2 outside the pit area). The borings should be ten feet deep and soil samples taken at regular intervals and at any interface. Analyses should be performed on water extractions and then analyzed for the parameters in List B (Table 6.2). b) Conduct geophysical survey to define the site boundaries and identify any leachate plume.	The 2 soil borings outside the pit area should be installed first, followed by the geophysical survey. The boring data are used to correlate the geophysical survey information. The results from the geophysical testing may indicate a need to change the depth of the 9 borings inside the pit area.
Landfill No. 2	65	Conduct geophysical survey, install lysimeters and sample the existing ground-water monitoring wells as described for Landfill No. 4. Lysimeters should be installed on all four sides of the landfill (one on each side). Also construct a background monitoring well at this site.	The pond should be drained to reduce the potential pathway for contaminant migration.
Industrial Waste Pit No. 1	61	Obtain soil borings and conduct geophysical survey using the same monitoring program as described for Industrial Waste Pit No. 2 (above).	

TABLE 6.1
(Continued)

Site	Rating Score	Recommended Monitoring	Comments
Landfill No. 3	60	Conduct geophysical survey, install lysimeters and sample the existing ground-water monitoring wells as described for Landfill No. 4. Lysimeters should be installed on al' four sides of the landfill.	May be able to identify location of RWDS-1022E with the geophysical survey.
RWDS 1030W	59	Collect a water sample from the discharge of the pond which is situated over the burial site. Analyze the water sample for gross alpha and gross beta radiation levels. After the pond has been drained, the surface area around the burial site should be scanned for beta and gamma radiation levels.	The pond over Landfill No. 2 will have to be drained to conduct beta and gamma radiation tests.
Landfill No. 6	56	Conduct geophysical survey, install lysimeters and sample the existing ground-water monitoring wells as described for Landfill No. 4. Lysimeters should be installed on all four sides of the landfill (one on each side). Also construct a background monitoring well at this site.	
Fire Training Area No. 1	55	Perform soil borings and conduct geophysical survey using the same monitoring program as described for Industrial Waste Pit No. 2 (above).	
Landfill No. 5	51	Conduct geophysical survey, install lysimeters and sample the existing ground-water monitoring wells as described for Landfill No. 4. Lysimeters should be installed on all four sides of the landfill. Also construct a background monitoring well at this site.	
Base Streams	--	a) Conduct a sediment sampling program on base streams (see Figure 6.1). b) Measure the water level in the streams and the existing monitoring wells to determine if the stream is the source of the shallow aquifer water.	Objective is to characterize sediments and define any pollutant migration.
Water Supply Wells	--	Conduct a water sample collection and analyses program for water supply wells Nos. 6, 7, 16, 18, 22, 23, 24, 25, 27 and 28. The parameters shown in List A of Table 6.2 should be used for the analyses of each sample.	

TABLE 6.2
RECOMMENDED LIST OF ANALYTICAL PARAMETERS

List A

Samples from:

- Lysimeters
- Ground-water monitoring wells
- Leachate
- Base water supply wells

Analyses to include:

- GC/MS scan
- Total organic carbon
- pH
- Copper
- Zinc
- Manganese
- Nickel
- Cyanide
- Phenol
- PCB
- Total dissolved solids
- Interim Primary Drinking Water Standards (selected list)

Arsenic	Lead	Endrin	2,4,5-TP Silvex
Barium	Mercury	Lindane	Radium
Cadmium	Nitrate	Methoxychlor	Gross Alpha
Chromium	Selenium	Toxaphene	Gross Beta
Fluoride	Silver	2,4-D	

List B

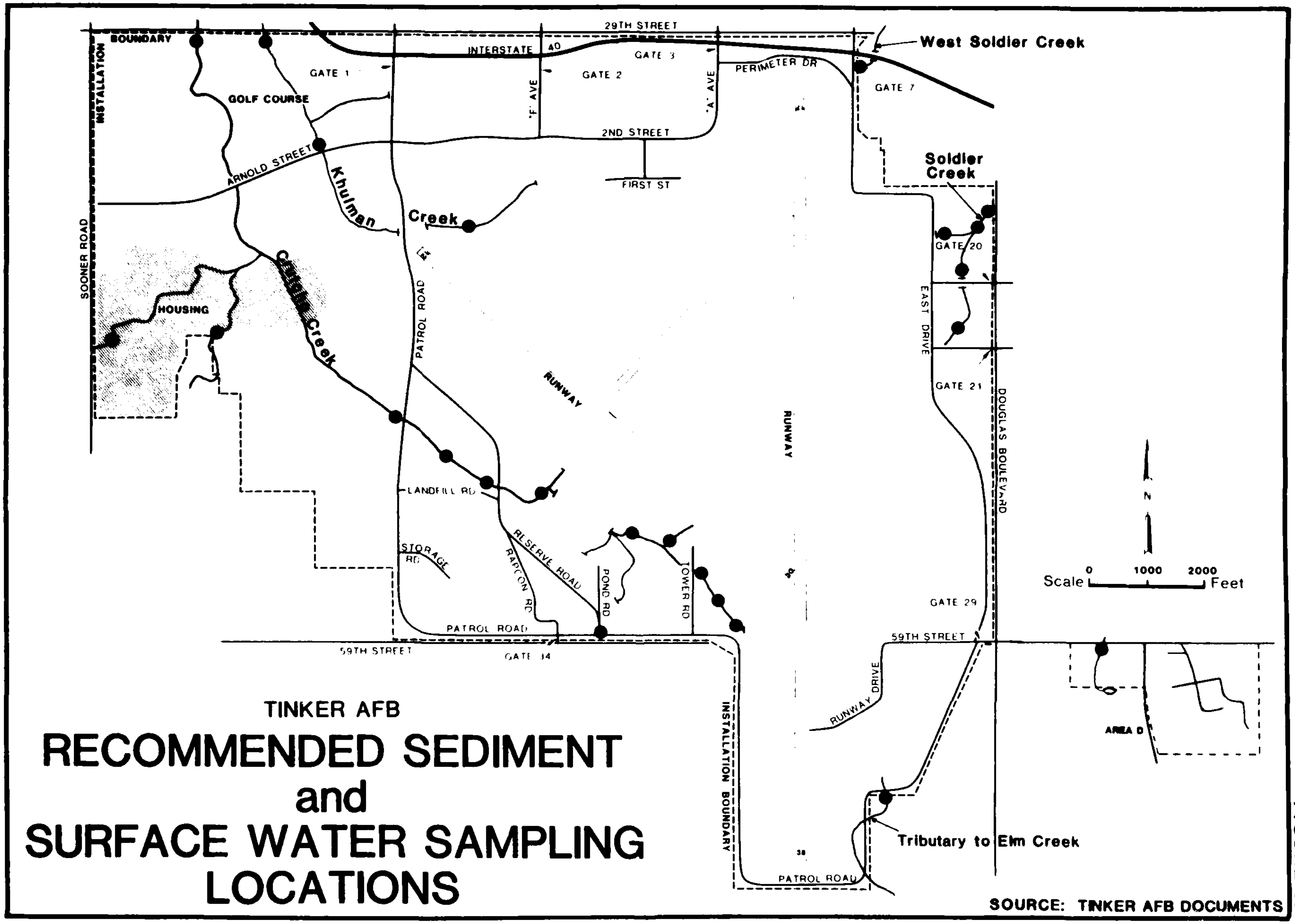
Samples from:

- Water extract of soil borings
- Stream sediment samples
- Stream water samples

Analyses to include:

- Interim Primary Drinking Water Standards (see above list)
- pH
- Total organic carbon
- Copper
- Zinc
- Manganese
- Total Dissolved Solids
- Nickel
- Cyanide
- Phenol
- PCB

FIGURE 6.1



TINKER AFB

RECOMMENDED SEDIMENT and SURFACE WATER SAMPLING LOCATIONS

SOURCE: TINKER AFB DOCUMENTS

APPENDICES

APPENDIX A

BIOGRAPHICAL DATA

J. R. Absalon, C.P.G.
D. G. Johnson
R. M. Reynolds, P.E.
E. J. Schroeder, P.E.
M. I. Spiegel

Biographical Data

JOHN R. ABSALON
Hydrogeologist

PII Redacted

[redacted]

Education

B.S. in Geology, 1973, Upsala College, East Orange, New Jersey

Professional Affiliations

Certified Professional Geologist (Indiana No. 46)
Association of Engineering Geologists
Geological Society of America
National Water Well Association

Experience Record

1973-1974 Soil Testing Incorporated-Drilling Contractors, Seymour, Connecticut. Geologist. Responsible for the planning and supervision of subsurface investigations supporting geotechnical, ground-water contamination, and mineral exploitation studies in the New England area. Also managed the office staff, drillers, and the maintenance shop.

1974-1975 William F. Loftus and Associates, Englewood Cliffs, New Jersey. Engineering Geologist. Responsible for planning and management of geotechnical investigations in the northeastern U.S. and Illinois. Other duties included formal report preparation.

1975-1978 U.S. Army Environmental Hygiene Agency, Fort McPherson, Georgia. Geologist. Responsible for performance of solid waste disposal facility siting studies, non-complying waste disposal site assessments, and ground-water monitoring programs at military installations in the southeastern U.S., Texas, and Oklahoma. Also responsible for operation and management of the soil mechanics laboratory.

1978-1980 Law Engineering Testing Company, Atlanta, Georgia. Engineering Geologist/Hydrogeologist. Responsible for the project supervision of waste management, water quality assessment, geotechnical, and hydrogeologic studies at commercial, industrial, and government

John R. Absalon (Continued)

facilities. General experience included planning and management of several ground-water monitoring programs, development of remedial action programs, and formulation of waste disposal facility liner system design recommendations. Performed detailed ground-water quality investigations at Robins Air Force Base in Georgia, a paper mill in southwestern Georgia, and industrial facilities in Tennessee.

1980-Date Engineering-Science. Hydrogeologist. Responsible for supervising efforts in waste management, solid waste disposal, ground-water contamination assessment, leachate generation, and geotechnical and hydrogeologic investigations for clients in the industrial and governmental sectors. Performed geologic investigations at eight Air Force bases and other industrial sites to evaluate the potential for migration of hazardous materials from past waste disposal practices. Conducted RCRA ground-water monitoring studies for industrial clients and evaluated remedial action alternatives for a county landfill in Florida.

Publications

"An Investigation of the Brunswick Formation at Roseland, NJ," 1973, with others, The Bulletin, Vol 18, No. 1, NJ Academy of Science, Trenton, NJ.

"Engineering Geology of Fort Bliss, Texas," 1978, with R. Barksdale, in Terrain Analysis of Fort Bliss, Texas, US Army Topographic Laboratory, Fort Belvoir, VA.

"Geologic Aspects of Waste Disposal Site Evaluations," 1980, with others, Program and Abstracts AEG-ASCE Symposium on Hazardous Waste Disposal, April 26, Raleigh, NC.

"Practical Aspects of Ground-Water Monitoring at Existing Disposal Sites," 1980, with R.C. Starr, Proceedings of the EPA National Conference on Management of Uncontrolled Hazardous Sites, HMCRI, Silver Spring, MD.

"Improving the Reliability of Ground-Water Monitoring Systems," 1981, Proceedings of the Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, University of Wisconsin-Extension, Madison, WI.

Biographical Data

DAVID G. JOHNSON

Environmental Engineer

PII Redacted

[redacted]

Education

B.S. in Civil Engineering with Highest Honors, University of Texas, Austin, Texas, 1977

M.S. in Engineering (Environmental Health), University of Texas, Austin, Texas, 1979

Professional Affiliations

Water Pollution Control Federation

Honorary Affiliations

Tau Beta Pi
Chi Epsilon
Phi Kappa Phi
Phi Eta Sigma

Experience Record

1976-77	University of Texas, Austin, Texas, Dept. of Civil Engineering - Research Assistant II. Performed data reduction and analysis and application of computer models to predict dynamic wheel loadings on pavements and bridges.
1977-78	University of Texas, Austin, Texas, Dept. of Engineering (Environmental Health) - Research Assistant II. Performed literature review and analysis of data pertaining to the sources and influx of nitrogen species into confined aquifers, and the fate of ammonia used for in-situ uranium solution mining.
1978-80	Espey, Huston & Associates, Inc. - Staff Engineer I. Preparation of Federal Flood Insurance Studies for thirteen coastal communities and four counties in Texas. Responsible for the data collection, hydrologic and hydraulic analyses and report writing, as well as coordination of staff engineers and technicians involved in the project. Extensive use was made of the computer program HEC-2. Represented the company at numerous community coordination meetings. Prepared outfall drainage studies for the communities of Refugio and Missouri City, Texas, outlining existing drainage problems and making recommendations to relieve them. Designed major drainage ditch improvements for a drainage system in Houston, Texas.

David G. Johnson (Continued)

1980-Present Engineering-Science, Inc. Project Engineer on 201 Step 1 studies for the communities of Edinburg and Sugar Land, Texas. Activities included preparation of an Environmental Information Document for Edinburg and Facility Plan for Sugar Land.

Project Engineer for Phase 1 Installation Restoration Program projects for the Department of Defense. Evaluated radioactive and hazardous materials handling and waste disposal activities at several Air Force bases to identify practices potentially resulting in groundwater contamination and contaminant migration beyond property boundaries. Past disposal sites were ranked to establish a priority basis for futher investigations.

Project Engineer involved with the preparation of an EIS for a new central Florida phosphate mine. Project activities included an analysis of radionuclide redistribution as a result of mining and an evaluation of potential radiological impacts.

Project Manager on an evaluation of fly ash disposal alternatives for a large power plant. Objectives of the project included assessment of collection, transportation, and disposal methods, as well as the potential for fly ash reuse.

Project Engineer in charge of coordinating bench-scale biological treatability studies on a coal gasification wastewater project. Systems using various amounts of powdered activated carbon were evaluated. Adsorption isotherms and temperature-rate dependency tests were also performed.

Project Engineer in charge of the preparation of conceptual wastewater treatment system design for a major oil refinery expansion. Activities included estimation of waste loads, and evaluation and conceptual design of collection and treatment facilities. Project Manager in charge of discharge permit preparation and application.

Project Engineer involved with the development of a wastewater management program for a major chemical company. Treatment technologies evaluated included granular carbon adsorption, powdered activated carbon adsorption in an activated sludge system, incineration, solvent extraction, steam stripping, chemical treatment, deep-well injection, and wet air oxidation.

Project Engineer in charge of coordination of bench-scale testing for a secondary oil removal and slop oil handling system for an organic chemical plant wastewater. Dissolved air flotation tests were run to

Biographical Data

Randal M. Reynolds

Senior Engineer

PII Redacted

[redacted]

Education

BChE (Chemical Engineering), 1973, Georgia Institute of Technology, Atlanta, Georgia

Professional Affiliations

Registered Professional Engineer, Georgia #13023
Air Pollution Control Association
American Institute of Chemical Engineers (Chapter Secretary)

Experience Record

1973-1975 U.S. Environmental Protection Agency, Water Enforcement Branch, Atlanta, Georgia. Chemical Engineer. Responsible for developing draft NPDES limitations for industrial discharges, issuing public notices and final NPDES permits and participating in public hearings concerning NPDES permits.

1975-1981 Gold Kist Inc., Corporate Engineering, Atlanta, Georgia. Environmental Process Engineer. Responsible for reviewing and implementing new air quality, NPDES, RCRA and TSCA regulations. Supervised preparation and submittal of air quality, water quality and hazardous waste permit applications. Kept management informed of impact of regulations on existing and future projects.

Served as staff engineer responsible for preparing preliminary designs for air pollution control systems and detailed cost estimates for air system capital projects. Major projects included the preliminary selection of alternatives for a particulate emission control system for a 60,000 lbs/hr industrial steam boiler (peanut hull/wood fired).

1981-Date Engineering-Science, Inc., Atlanta, Georgia. Senior Engineer. Responsibility for developing environmental studies and alternative evaluations for clients.

Randal M. Reynolds, Continued

Project Engineer for Phase I Installation Restoration Program projects for the Department of Defense. Developed hazardous chemical usage, waste generation and waste disposal practice timelines for industrial operations at several Air Force bases. Identified industrial operation disposal practices which could result in migration of contaminants and recommended priority disposal practices requiring further investigation.

Project Engineer assisting in a comprehensive study of the solid waste management program for the City of Roswell, Georgia. Developed conceptual cost estimates for a city operated sanitary landfill and incinerator disposal alternatives.

Project Manager for development of a Spill Prevention Control and Countermeasures (SPCC) Plan for an industrial facility. Coordinated the design of spill containment structures and recommended structure modifications. Recommended essential spill control and clean-up equipment.

Publications and Presentations

R. M. Reynolds, "Practical Tips - Bagging Sludge?", Pollution Engineering, Vol. 12, No. 7, July 1980, pg. 28.

R. M. Reynolds, "Pulse-Type Fabric Filters in a Soybean Processing Facility," Operation and Maintenance of Air Particulate Control Equipment, R. A. Young, F. L. Cross, Jr., editors, Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan, July 1980, pp. 121-123.

"Operation, Maintenance and Design of Fabric Filters for a Soybean Processing Facility," a slide presentation for the EPA technology transfer serminar, "Operation and Maintenance of Air Pollution Equipment for Particulate Control," April 12, 1979, Atlanta, Georgia.

Biographical Data

ERNEST J. SCHROEDER

Environmental Engineer
Manager, Solid and Hazardous Waste

PII Redacted

[redacted]

Education

B.S. in Civil Engineering, 1966, University of Arkansas, Fayetteville, Arkansas
M.S. in Sanitary Engineering, 1967, University of Arkansas, Fayetteville, Arkansas

Professional Affiliations

Registered Professional Engineer (Arkansas No. 3259, Georgia No. 10618, Texas No. 33556 and Florida No. 0029175)
Water Pollution Control Federation

Honorary Affiliations

Chi Epsilon

Experience Record

1967-1976 Union Carbide Technical Center, Engineering Department, South Charleston, West Virginia (1967-1968). Project Engineer. Responsible for environmental protection engineering projects for various organic chemicals and plastics plants. Conducted industrial waste surveys, landfill design, and planning for plant environmental protection programs; evaluated air pollution discharges from new sources; reviewed a wastewater treatment plant design; and participated on a project team to design a new chemical unit.

Union Carbide Corporation, Environmental Protection Department, Texas City, Texas (1969-1975). Project Engineer and Engineering Supervisor. Responsible for various aspects of plant pollution abatement programs, including preparation of state and federal permits for wastewater treatment activities.

Operations Representative on $8 million regional wastewater treatment project and member of design team which made the initial site selection and process evaluation

ERNEST J. SCHROEDER (Continued)

and recommendation. Participated in contract negotiations, process and detailed engineering design, construction of the facilities, preparation of start-up manuals, operator training, and the start-up activities. Designated as Project Engineer after start-up on expansion to original waste treatment unit.

Engineering Supervisor responsible for operation of wastewater treatment facilities including collection system, sampling and monitoring programs, spill control and clean-up, primary waste treatment, wastewater transfer system, biological waste treatment, and waste treatment pilot plants. Developed odor control program which successfully reduced odor emissions and represented Union Carbide at a public hearing on community odor problems.

Led special projects such as an excess loss control program to reduce water pollution losses; sewer segregation program involving coordination and reporting of 38 projects for the separation of contaminated and non-contaminated water; and sludge disposal program to develop long-term sludge disposal alternatives and recover land in present sludge landfill area. Developed improved methods of sampling and continuous monitoring of wastewater.

Union Carbide Corporation, *Environmental Protection* Project Engineer, Toronto, Ontario, Canada (1975-1976). Responsible for the overall environmental permitting, engineering design, construction and start-up of waste treatment systems associated with a new refinery.

1976-Date Engineering-Science, Inc., Project Manager (1976-1978). Responsible for several industrial wastewater projects including the following: wastewater investigation to characterize sources of waste streams in a chemical plant and to develop methods to reduce the wastes, sludge settling studies to evaluate settling characteristics of activated sludge at a chemical plant, development of a process document for the design and operation of a wastewater treatment facility at a petrochemical complex, wastewater treatment evaluation which included characterization of wastewater, unit process evaluation, inhibition studies, design review, operations review, preparation of operations manual, operator training and providing operating assistance for waste treatment facilities, various biological treatability studies and bench-scale and pilot-scale evaluation of advanced waste treatment technologies such as granular carbon adsorption, multimedia filtration, powdered activated carbon treatment, ion exchange and ozonation.

ERNEST J. SCHROEDER (Continued)

Project Manager for hazardous waste disposal projects involving waste characterization, development of criteria for disposal of hazardous waste, site investigation, preparation of permits, detailed design, construction of facilities and spill clean-up activities.

Deputy Project Manager for industry-wide pilot plant study of advanced waste treatment in the textile industry. Technologies evaluated included coagulation/clarification, multi-media filtration, granular carbon adsorption, powdered activated carbon treatment, ozonation and dissolved air flotation.

Engineering-Science, Inc., Manager of the Industrial Waste Group in the Atlanta, Georgia office (1978-1980). Responsible for the supervision of industrial waste project managers and project engineers and the management of industrial waste studies conducted in the office. Also directly involved in project management consulting with clients on environmental studies and environment assessment projects, e.g., project manager for several spill control and wastewater treatability projects and for a third-party EIS for a new phosphate mine in Florida.

Engineering-Science, Inc., Manager of Solid and Hazardous Waste Group in the Atlanta, Georgia office (1980-date). Responsible for the supervision of solid and hazardous waste project managers and project engineers and the management of solid and hazardous waste projects in the office. Project activities have included permit and regulatory assistance, environmental audits, waste management program development, ground water monitoring, landfill evaluations, landfill closure design, hazardous waste management, waste inventory, waste recovery/recycle evaluation, waste disposal alternative evaluation, transportation evaluation, and spill control and countermeasure planning.

Project Manager for several Phase I Installation Restoration Program projects for the U.S. Air Force. The objective of this program is to audit past hazardous waste disposal practices that could result in migration of contaminants and recommend priority sites requiring further investigation. Also conducted environmental audits (air, water and solid waste) at several Gulf Oil Company facilities.

ERNEST J. SCHROEDER (Continued)

Publications and Presentations

Schroeder, E. J., "Filamentous Activated Sludge Treatment of Nitrogen Deficient Waste," research paper submitted in partial fulfillment of the requirements for MSCE degree, 1967.

Schroeder, E. J., and Loven, A.W., "Activated Carbon Adsorption for Textile Wastewater Pollution Control," Symposium Proceedings: Textile Industry Technology, December 1978, Williamsburg, VA.

Schroeder, E. J., "Summary Report of the BATEA Guidelines (1974) Study for the Textile Industry," North Carolina Section of AWWA/ WPCA, Pinehurst, North Carolina, November 1979.

Mayfield, R. E., Sargent, T. N. and Schroeder, E. J., "Evaluation of BATEA Guidelines (1974) Textiles," U.S. EPA Report, Grant No. R-804329, February 1980.

Storey, W. A., and Schroeder, E. J., "Pilot Plant Evaluation of the 1974 BATEA Guidelines for the Textile Industry," Proceedings of the 35th Industrial Waste Conference, Purdue University, May 1980.

Pope, R. L., and Schroeder, E. J., 'Treatment of Textile Wastewaters Using Activated Sludge With Powdered Activated Carbon," U.S. EPA Report, Grant No. R-804329, December 1980.

Schroeder, E. J., "Industrial Solid Waste Management Program to Comply with RCRA," Engineering Short Course Instructor, Auburn University, October 1980.

Schroeder, E. J., "Technical and Economic Impact of RCRA on Industrial Solid Waste Management, Florida Section, American Chemical Society, May 1981.

Biographical Data

MARK I. SPIEGEL

PII Redacted

Environmental Scientist

[redacted]

Education

B.S. in Environmental Health Science (Magna cum laude), 1976, University of Georgia, Athens, Georgia
Limnology and Environmental Biology, University of Florida, Gainesville, Florida
Business Administration, Georgia State University

Professional Affiliations

American Water Resources Association
Technical Association of the Pulp and Paper Industry

Experience Record

1974-1976 U.S. Environmental Protection Agency, Surveillance and Analysis Division. Cooperative Student. On assignment to Air Surveillance Branch, participated in ambient air study in Natchez, Mississippi, and operated unleaded fuel sampling program for Southeast National Air Surveillance Network. For Engineering Branch, participated in NPDES compliance monitoring of industrial facilties throughout the southeast; operation and maintenance studies of municipal waste treatment facilities; and post-impoundment study of West Point Reservoir, West Point, Georgia. Participated in industrial bioassay studies for the Ecological Branch.

1977-Date Engineering-Science. Environmental Scientist. Responsible for the conduct of water and wastewater sampling programs and analyses, quality control, laboratory process evaluations, and evaluation of other environmental assessment data. Conducted leachate extraction studies of sludges produced at a large organic chemicals plant to define nature of sludges according to the Resource Recovery and Conservation Act guidelines. Involved in laboratory quality assurance program for the analysis of water samples used in a stream modeling project. Conducted water quality modeling study for Amerada Hess Corporation to determine the assimilative capacity of a stream receiving effluent from a southern Mississippi refinery.

Mark I. Spiegel (Continued)

Participated in bench-scale industrial treatability studies conducted for the American Textile Manufacturers Institute and Eli Lilly Pharmaceuticals in Mayaguez, Puerto Rico, and in carbon adsorption studies for an American Cyanamid chemical plant and Union Carbide Agricultural Products Division.

Involved in various aspects of several industrial environmental impact assessments including preliminary planning for a comprehensive study for St. Regis Paper Company on a major pulp and paper mill expansion project. Assisted in preparation of third-party EIS for EPA and Mobil Chemical Company concerning a proposed 16,000-acre phosphate mining and beneficiation facility. Developed an EIA prior to construction of a pulp and paper complex by the Weyerhaeuser Company in Columbus, Mississippi, which included preparation of a separate document for the Interstate Commerce Commission concerning the construction of a railroad spur to serve the complex. Also involved in formulating the water quality, water resource and socio-economic aspects of an environmental impact assessment for International Paper Company. Participated in large scale site evaluation to determine the suitability and environmental permitting requirements of a site for an east coast brewery for the Adolph Coors Company. Assisted in development of a peat mining and restoration plan for a private concern in coastal North Carolina.

Project Manager. Conducted comprehensive process evaluation of an 80 mgd wastewater treatment system for Weyerhaeuser Company. Responsible for a study to determine the leaching characteristics of sludges for a paint manufacturing facility for RCRA compliance. Also managed study for development of a solid waste management plan for a ceramic pottery manufacturer in northern Alabama which included evaluating surface and groundwater contamination potential from the existing disposal site and assisting manufacturer in developing a disposal program acceptable to state agencies.

Participated as project team member for Phase I Installation Restoration Program projects for the Department of Defense. Studies were conducted at five Air Force bases to identify past hazardous waste disposal practices that could result in migration of contaminants and recommend priority sites requiring further investigation.

APPENDIX B

INSTALLATION HISTORY, ORGANIZATIONS AND MISSIONS

APPENDIX B

INSTALLATION HISTORY, ORGANIATIONS AND MISSIONS

The information presented in this Appendix was obtained primarily from Tinker AFB records.

The site of Tinker Air Force Base was selected by the Site Board of the Army Air Force in March 1941. Two months later approval was granted to build a maintenance and supply depot southeast of Oklahoma City on the 960 acre site donated by the citizens of Oklahoma City. Approximately seven months before the United States formally entered World War II, 21 May 1941, the proposed installation was designated the Midwest Air Depot. Groundbreaking ceremonies were conducted that same year, on 30 July 1941, with subsequent activation of the installation on 1 March 1942. During this same time period, Midwest City sprang up as a new town to provide housing and community facilities for the new air depot. The original land acquisition for the new city consisted of 310 acres adjacent to, and north of, the new air maintenance and supply depot.

During the initial construction of the installation a nucleus of military and civilian personnel operated from a commercial building in downtown Oklahoma City. The first increment of personnel moved to the site on 20 July 1942 which, at that time, consisted of a base comprising 1,660 acres and 420 unfinished buildings. By August of that year supply and maintenance functions were on-site and operating at a furious pace. As the mission accelerated, so did employment. Civilian employment reached a World War II peak in October 1943 with 14,925 on the payroll. During World War II the Midwest Air Depot was responsible for reconditioning, modification and modernization of aircraft, vehicles and equipment. The geographical area for prime responsibility at the time consisted of Minnesota, Wisconsin, Iowa, Illinois, Missouri, Arkansas, Nebraska, Kansas, Oklahoma and that portion of Texas north of the 33rd parallel, north latitude.

During the interim, on 14 October 1942, the depot was designated Tinker Field in honor of Maj. Gen. Clarence L. Tinker, a native of Oklahoma. The one-eighth Osage Indian was killed in action on 7 June 1942 while leading his bomber command on a strike against the Japanese at Wake Island.

Next came a series of name changes as the parent command redesignated the depot three times in just under two years. On 20 January 1943, as the depot assumed control of sub-depots and detachments, it became the Oklahoma City Air Depot Control Area Command. Again, it was called the Oklahoma City Air Command, and then, on 14 November 1944, the base became the Oklahoma City Air Technical Service Command. Throughout the war years Tinker compiled an imposing record for its maintenance on B-24 Liberators, B-29's, B-17's and thousands of aircraft engines. Though some 7,000 military and civilian personnel were separated following the war's conclusion, the base area expanded when the Douglas Aircraft Plant, located east of the north-south runway, was combined with the Base. The base was officially dedicated "Tinker Field" on 18 November 1945. The installation at this time had a value of $55 million and was among the largest in the United States.

On 2 July 1946, the Oklahoma City Air Technical Service Command became the Oklahoma City Air Materiel area (OCAMA), following the ASC's redesignation as the Air Materiel Command. During this time frame, Tinker became involved in jet engine overhaul and, later, modification of aircraft out of storage in a huge program to rebuild the nation's airpower. The base's first peace time overhaul project was the preparation of "Dave's Dream," and the "Enola Gay," and several other B-29's for the important Bikini atomic test program. On 13 January 1948, Tinker Field became Tinker Air Force Base. Subsequently, the base became the worldwide repair depot for the B-36 aircraft, and its first jet aircraft, a B-45, plus a multitude of other weapons and engines.

The outbreak of hostilities in Korea in 1950 placed new demands on Tinker. Maintenance's repair of aircraft increased 57 percent, largely in support of the Korean action. Furthermore, by August 1952, military and civilian personnel had grown to an all time high of almost 29,000.

Concurrently, Tinker's air material headquarters responsibilities were enlarged. For example, in January 1954, OCAMA was assigned all logistics functions, from acquisition through operations, on the new B-52 bomber and also received like responsibilities on the C/KC-97 and B-47 aircraft. In the late 50's, management of missiles was added to the logistics mission. Then, during the years 1961-1963, the installation became the specialized repair site for C-135 aircraft, airborne communications equipment, and became the single overhaul point for the J-57 engine and related accessories. In 1966, OCAMA gained the management assignment on the A-7 attack aircraft.

During 1951 the Air Force acquired a parcel of land located one half mile east of the southeast corner of Tinker AFB (Area "D"). The area was named the Oklahoma City Air Force station and was supported by Tinker AFB. In 1956, the area officially became a separate entity; however, support was still provided by Tinker AFB. The area was initially occupied by the 33rd Air Division and is presently occupied by the Engineering Installations Center, part of the Air Force Communications Command. In 1954, the base acquired a parcel of land south of the 59th Street boundary to extend the existing main runway. The land acquisition consisted of approximately 300 acres. During 1956, the base acquired additional land in the same area completing the parcel of land south of 59th street presently within Tinker AFB jurisdiction. With the acquisition in 1957 of a 638 acre tract of land immediately west of the original air base, development of new permanent military housing and community support facilities commenced. Included in the development, at that time, was a 75-bed hospital, dental clinic, Officer quarters, 268 Capehart-Act family residences, Airmen dormitories and dining hall.

The United States' involvement in the Vietnam war had a major impact on OCAMA in the late 1960's. OCAMA managed, bought, repaired and stored dozens of weapons and prime items in support of that conflict. During the 1970's the installation took on new management responsibilities such as the B-1 bomber, the F-101 engine, the AGM-86A missile and other items. Also, on 1 April 1974, OCAMA was again redesignated; this time as the Oklahoma City Air Logistics Center. Additionally, the real estate value of Tinker AFB had risen to approximately $166 million.

Foresighted base officials and community leaders had taken joint measures to protect Tinker AFB from encroachment. The most striking example of community interest in Tinker's welfare occurred on 8 May 1973 when Oklahoma County residents overwhelmingly voted approval of $10.8 million in bonds to clear a housing area under the northern approach to the base's primary runway. The area, approximately 3,000 feet wide by a mile in length, comprised of 836 houses, one school and other land, historically presented the only hazard to Tinker's flying operations and has long been a concern to residents and base officials alike. The clearance project began in the summer of 1973.

With the support of community leaders the Base acquired 187 acres of land contiguous to the base on 20 June 1975 in exchange for a 10 acre tract which was formally used as a communications transmitter site.

ORGANIZATIONS AND MISSIONS

Primary Mission

Presently Tinker AFB has a multi-fold flying mission consisting of A-7, B-52, C-135, E-3A, F-4 and numerous cargo aircraft. The flying mission of the host base consists mainly of logistics support and administrative flight and pilot proficiency training. The missions associated with the A-7, B-52 and C-135 aircraft are production flight checks of these aircraft that have undergone depot maintenance, repair and/or modification. The 552nd Airborne Warning and Control Wing (TAC) operates and maintains the USAF fleet of E-3A Sentry aircraft (AWACS). Tinker AFB was established as the main, operating and training base for the E-3A fleet in 1977. The E-3A is an integral part of the Tactical Air Command's Mobile Strike Force capability and is depolyed worldwide in response to international situations.

The Det 507, 301 Tatical Fighter Wing performs tactical fighter training in the F-4 aircraft. This aircraft is a fighter bomber with the training accomplished to maintain combat proficiency and readiness of the personnel and aircraft. Training consists of on the average of 16 sorties per day sent to gunnery ranges to practice bombing and strafing and also maneuverability exercises. The gunnery ranges utilized for these training requirements are Falcon Gunnery Range, Fort Sill, Oklahoma; Razorback Gunnery Range, Fort Smith, Arkansas; and the Smokey Hill Range, Salina, Kansas. The training requirements of this reserve unit is the same as for an active duty unit. In addition to the above missions, various cargo aircraft utilize Tinker runways as a result of the air freight terminal operations and numerous other transient aircraft. Tinker is the only inland aerial port of embarkation for the Air Force.

The 2854 Air Base Group is the host organization at Tinker AFB which employs approximately 13 percent of the personnel assigned to the installation. As host, its mission is to support the remaining 87 percent of the employees assigned to the Oklahoma City Air Logistics Center and approximately 40 other activities. These other activities include a wide variety of military organizations from several commands, and also a few civilian organizations, such as American Red Cross, who provide services to base military personnel.

In its responsibility for the Air Logistics Command installation, the 2854 ABG is charged with the operation and maintenance of real property in support of the tenants. This amounts to over 11 million square feet of floor space alone. Through host-tenant support agreements, the Group provides utilities, communications, supplies, transportation, staff assistance and other services necessary for the tenants to accomplish their individual missions.

The Oklahoma City Air Logistics Center is the major organization at Tinker AFB. The mission of the Oklahoma City Air Logistics Center is to provide logistic support to the operating commands of the United States Air Force. Logistics, which has been defined as the "function of providing all materiel and services the military needs in peace or war," is so important that USAF has an entire Command, the Air Force Logistics Command (AFLC), to provide the support.

The functions of AFLC are substantially accomplished through five Air Logistics Centers, of which Oklahoma City Air Logistics Center is one of the largest. Every operational USAF installation in the world looks to the Oklahoma City Center for some part of its logistic support. The basic functions of the Center may be divided into three principal areas: logistics support management, technical and engineering, and industrial.

Logistics support management includes the accomplishment, or surveillance, of many functions for the equipment assigned: requirements computation; budgeting and buying; storage and distribution of stocks;

assignment of repair and modification; product improvement; and disposition of obsolete items.

The Oklahoma City Air Logistics Center is logistic support manager for almost all of the Strategic Air Command's bomber and tanker fleet. In addition, it manages certain jet transport aircraft including the President's aircraft and the A-7D attack plane. Three air-launched missiles are managed: the decoy missile known as the Quail; the Hound Dog Missile; and the Short Range Attack Missile (SRAM). The Oklahoma City Air Logistics Center also manages a substantial portion of the engines in the Air Force inventory. Essentially, these are engines manufactured by General Electric, Pratt & Whitney and Allison, and include such modern engines as the TF-30, TF-41, TF-33, J-57 and J-79. Finally, the Oklahoma City Air Logistics Center manages approximately 140,000 items in the hydraulics, pneumatics and instrument areas.

The Center's technical and engineering capability is vital to the maintenance of a first rate up-to-date Air Force. The Center's engineers and technicians provide specific fixes for in-service revealed deficiencies as well as develop longer range plans for continued materiel improvement. Another important technical and engineering task the Center performs is carried out in the Precision Measurement Equipment Laboratory. The accuracy of such equipment, both belonging to Tinker AFB organizations and to AF units throughout the central part of the United States, is periodically checked. This includes such equipment as hydrometers, dimensional standards for gauge blocks, microwave standards, etc.

As an industrial facility, the Oklahoma City Air Logistics Center operates a tremendous overhaul and modification complex engaged in repairing and upgrading aircraft, a vast quantity of engines and many thousands of accessory items. Playing a large part in the Center's industrial support are supply and transportation facilities which receive, store, issue and transport the equipment being worked in the Center's shops, as well as a multitude of items used by base and tenant activities.

Four major directorates of the Oklahoma City Air Logistics Center are (1) Distribution, (2) Maintenance, (3) Procurement and Production and (4) Materiel Management. The mission of these four directorates is described as follows:

(1) The Directorate of Distribution is responsible for the direction of Air Force depot level operations to accomplish the receipt, storage, issue and shipment of material.

(2) The mission of the Directorate of Maintenance is to provide logistical support to the Air Force by accomplishing the repair, maintenance and modification of those items of Air Force equipment which are assigned as specialized repair activity, and to provide area support assistance to activities within the eight state Oklahoma City Air Logistics Center geographical area.

(3) The Directorate of Procurement and production provides management over internal operational functions associated with the procurement of material and services as assigned in accordance with applicable Air Force directives and limitations, including the application of the selective management philosophy in executing assigned functions when practical.

(4) The Directorate of Materiel management is responsible for worldwide logistics management of assigned weapon/support systems and commodity classes from the time of their introduction into the Air Force inventory until the time of disposal. The Directorate must insure that the systems and commodities are fully supported and maintained in an optimum state of readiness. Consequently, the Directorate is responsible for provisioning, cataloging and standardization, requirements determination, budgeting and buying, stock control and distribution, product improvement, repair and modification, and maintenance technical services and assistance actions.

TENANT MISSION

552nd Airborne Warning and Control Wing (AWAC): Operates and maintains the USAF fleet of E3-A Sentry aircraft. The wing conducts training missions and provides an integral role in the Tactical Air Commands' mobile strike force capability. The E3-A is deployed worldwide in response to international situations.

Engineering and Installation Center: Provides telecommunications, air traffic control and ground electronics engineering and installation in an 18 state area of the southern United States and Puerto Rico.

Det 507, 301 Tactical Fighter Wing: A self-sustaining Air Force Reserve organization, formerly with an airlift mission, but now with a tactical fighter capability.

3rd Combat Communications Group: Specializes in providing communications and navigational aid support any place in the Western Hemisphere.

Communications Computer Programming Center: Provides electronic data processing programming services for the Air Force Communications Service (AFCS).

6th Weather Squadron Mobile: Provides mobile worldwide meteorological units capable of making surface micro-meteorological and upper air weather observations in support of USAF and DOD projects and other governmental agencies and departments.

Air Force Audit Agency Office (Resident Auditor): Performs internal audits of all Air Force activities on Tinker AFB.

Defense Logistics Agency, Memphis Region: A staff office of the Memphis Region Commander provides technical assistance to or surveillance of actions pertaining to property disposal for the geographical region comprising of the State of Oklahoma and the north central part of Texas.

Defense Property Disposal Office, Okalhoma City: Under the Direction of the Commander Defense Property Disposal Region, Memphis, Tennessee, performs in support of the military services and other authorized customers, property disposal service operations, including the receipt, control, warehousing and preparation of excess and surplus personal property for reutilization, donation, sale or other dispositions.

USAF Hospital, Tinker: Provides complete medical care for all qualified personnel and dependents.

2953rd Combat Logistics Support Squadron: Provides Rapid Area Maintenance (RAM) and Rapid Area Distribution (RADS) support to U.S. Forces, worldwide. Augment depot work force.

Det 2, 3025 Mes AFLC Mgt Engr Team: Maintains effective manpower and management engineering programs for activities services.

1984th Communications Squadron: Provides complete air base navigation aids, air traffic control and communications support for Tinker AFB.

AF Office of Special Investigation (11th District): Provides USAF activities in Oklahoma and northern Texas with criminal investigation services, personnel security investigations and counter-intelligence.

Corps of Engineers, Resident Engineer: Provides supervision and inspection for military construction.

Department of Transportation, Federal Aviation Administration: Provides area air traffic control, maintains flight inspection of electronic equipment and supports the Fort Worth air traffic control center.

Det 1, 60th Military Airlift Wing: Provide in route logistics support for MAC military airlift aircraft transiting Tinker AFB in support of OCALC worldwide channels.

Det 1, 17th Weather Squadron: Provides weather service to Oklahoma City Air Logistics Center, base and tenant assigned aircraft and all transient aircraft.

Others:

- Det 15, 1365th Audio Visual Sq.
- Military Air Traffic Coordinators Office.
- General Services Administration.
- U.S. General Accounting Office.
- 403rd Combat Logistics Support Sq. (Reserves).
- OLCA 2400th Reserve Readiness and Mobile Sq. (Reserves).
- 72nd Aerial Port Squadron (Reserves).
- Red Cross.
- Tinker Credit Union.
- First National Bank of Midwest City.

APPENDIX C

SUPPLEMENTAL ENVIRONMENTAL SETTING INFORMATION

APPENDIX C
SUPPLEMENTAL ENVIRONMENTAL SETTING INFORMATION

BIOLOGICAL RESOURCES

The following information regarding the Tinker AFB biological resources was obtained from Tinker AFB records.

The site of Tinker AFB is situated on a relatively flat expanse of grassland. Prior to the development of the base, the area was characterized by large expanses of agricultural land. At the present time, the base has approximately 1,630 acres of semi-improved and unimproved grounds which are used for the airfield, golf course, housing area, offices and shops. Naturally occurring ecosystems are, therefore, limited on base. The only wooded areas on base are situated along Crutcho Creek and Soldier Creek. No endangered or threatened plants are located within the base. The following list indicates the endangered and threatened animals which, due to their migratory habits, may occasionally visit the area.

Endangered Species:

- Southern Bald Eagle
- Prairie Falcon
- Artic Peregrine Falcon

Threatened Species:

- American Peregrine Falcon
- American Ivory-Billed Woodpecker

SUMMARY OF SURFACE WATER QUALITY DATA

Surface water quality data available from base records, State agencies and private studies are shown in Tables C.1, C.2, C.3, and C.4.

TABLE C.1

MONITORING DATA COLLECTED BY TINKER AFB BIOENVIRONMENTAL ENGINEERING

Station Number and Location	Date	COD mg/l	O & G mg/l	NH_3-N mg/l	NO_3-N mg/l	Ortho-Phosphate mg/l	CN mg/l	Phenol µg/l	Cd µg/l	Cr (Tot) µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Mn µg/l	Hg µg/l	Ni µg/l	Zn mg/l	Cl^- mg/l	TSS mg/l	$SO_4^=$ mg/l	Surfactants[*] mg/l
Soldier Creek 275 Ft. E. Bldg. 62510	5/30/80	2	<0.3	2.3	1.1	0.9	0.04	<10	10	133	<20	168	<50	91	<5	92	<50	28	12	200	0.3
	6/11/80	23	<0.3	2.4	1.6	1.7	0.04	<10	<10	200	22	232	<50	153	<5	308	<50	24	12	45	0.3
	7/15/80	28	1.8	1.5	2.5	2.6	0.02	12	30	1119	38	466	<50	368	<5	802	<50	32	31	25	0.2
	7/25/80	95	1.6	5.0	1.6	8.0	0.03	38	<10	23800	127	7380	303	1343	<5	2899	231	20	178	14	0.34
	7/31/80	30	0.8	9.0	2.3	12.5	<0.01	10	<10	224	44	137	<50	166	5	355	<50	32	13	16	0.16
	8/14/80	10	1.72	4.0	1.4	5.2	<0.01	10	10	107	56	106	<50	213	<5	329	<50	52	6	275	0.24
	9/23/80	68	1.1	5.0	0.8	1.6	0.02	<10	10	125	40	101	<50	197	<5	258	<50	36	9	14	0.2
	10/14/80	25	0.8	3.0	1.1	0.7	<0.01	<10	10	101	103	143	<50	135	<2	195	<50	24	<1	220	0.01
West Soldier Ck. (60 Ft. S. Bldg. 3116)	1/10/74	-	-	2.7	0.4	<0.2	<0.01	<10	24	<50	54	170	<50	<50	<5	<50	<50	16	3	6	0.2
	2/13/79	10	<0.3	6.0	1.3	<0.2	<0.01	<10	<10	<50	32	<100	<50	<50	<5	83	68	8	5	9	0.1
	2/27/79	10	<0.3	2.0	0.5	<0.2	<0.01	<10	<10	<50	<20	<100	<50	<50	<5	53	85	16	5	7	<0.1
	3/8/79	80	8.4	<0.2	<0.1	<0.2	<0.01	22	<10	180	52	350	<50	61	<5	<50	140	16	6	11	<0.1
	3/26/79	90	13.2	<0.2	<0.2	<0.2	<0.01	24	<10	<50	130	260	<50	<50	5.2	68	110	16	9	8.0	0.1
	4/6/79	120	6.6	<0.2	0.3	<0.7	<0.01	18	<10	<50	53	240	<50	<50	<5	<50	130	12	25	11	0.2
	4/12/79	120	0.4	<0.2	1.5	<0.2	<0.01	15	<10	<50	50	790	<50	<50	<5	<50	<50	28	<1	9	0.1
	4/30/79	580	80	9.8	<0.1	1.5	24	25	<10	<50	110	78	<50	<5	<5	<50	75	20	54	7	0.1
	5/25/79	<10	<0.3	<0.2	0.7	<0.2	<0.01	<10	18	87	<20	100	50	<50	<5	<50	<50	32	4	14	<0.1
	7/2/79	90	<0.3	<0.2	<0.1	<0.2	<0.01	<10	<10	224	48	104	<50	<50	<5	<50	<50	16	3	20	<0.1
	7/13/79	30	1	0.3	0.4	0.2	<0.01	10	<10	1200	180	530	<50	220	<5	<50	<50	20	8	10	<0.1
	7/31/79	<10	<0.3	<0.2	0.4	<0.2	<0.01	10	10	<50	77	<100	<50	<50	<50	<50	<50	8	3	7	0.1
Khulman Ck. (Central) (320 Ft. S. Bldg. 66061)	3/6/80	<10	<0.3	0.5	1.3	<0.2	<0.01	<10	<10	<50	<20	149	<50	62	<5	<50	<50	80	18	22	<0.1
	3/21/80	30	<0.3	<0.2	1.2	<0.2	<0.01	<10	<10	<50	<20	297	<50	83	<5	<50	<50	56	8	19	<0.1
	4/15/80	20	<0.3	<0.2	1.4	<0.2	<0.01	<10	<10	<50	<20	154	<50	77	<5	<50	<50	92	<1	25	<0.1
	4/21/80	<10	<0.3	<0.2	1.1	<0.2	<0.01	<10	<10	<50	<20	240	<50	77	<5	<50	<50	80	13	30	<0.1
	5/22/80	25	<0.3	0.4	1.0	<0.2	<0.01	<10	<10	<50	<20	164	<50	186	<5	<50	56	40	2	22	<0.1
	5/30/80	22	1.2	<0.2	1.2	<0.2	<0.01	<10	<10	<50	<20	249	<50	229	<5	228	<50	40	9	24	<0.1
	6/11/80	13	1.2	0.3	0.3	<0.2	<0.01	<10	<10	<50	<20	1405	52	1361	<5	<50	<50	84	35	19	<0.1
	7/15/80	<10	0.6	<0.2	1.2	<0.2	<0.01	<10	<10	<50	<20	418	<50	111	<5	<50	<50	80	17	24	<0.1
	7/25/80	25	<0.3	0.2	1.2	<0.2	<0.01	<10	<10	<50	<20	273	<50	98	<5	<50	<50	64	9	23	<0.1
	7/31/80	25	0.32	0.3	1.0	<0.2	<0.01	<10	<10	<50	20	1861	122	319	<5	<50	57	60	35	22	<0.1
	8/14/80	10	0.68	0.2	0.7	<0.2	<0.01	<10	<10	<50	36	323	<50	349	<5	<50	1440	16		12	<0.1
	9/23/80	<10	<0.3	<0.2	0.6	<0.2	<0.01	<10	<10	<50	<20	128	<50	<50	<5	<50	428	48	4	550	<0.1
	10/14/80	10	0.7	<0.2	0.5	<0.2	<0.01	<10	<10	<50	37	151	<50	57	<2	<50	506	24	9	9	<0.1
Khulman Ck. (North) (150 Ft. S. Bldg. 6619)	3/6/80	30	<0.3	2.1	0.5	<0.2	<0.01	<10	<10	<50	20	394	50	256	<5	<50	<50	60	8	21	0.2
	3/21/80	70	<0.3	1.0	1.1	<0.2	<0.01	12	<10	<50	<20	523	<50	511	<5	<50	<50	216	27	28	0.2
	4/15/80	70	<0.3	1.1	0.2	0.3	<0.01	<10	<10	<50	<20	1361	<50	1317	<5	<50	<50	176	28	33	<0.1
	4/21/80	30	<0.3	0.3	0.1	<0.2	<0.01	10	10	<50	20	719	<50	1711	<5	<50	<50	152	33	12	0.1
	5/22/80	35	<0.3	0.3	0.7	<0.2	<0.01	<10	<10	<50	20	329	<50	253	5	<50	<50	92	67	28	<0.1
	5/30/80	22	<0.3	0.4	0.3	<0.2	<0.01	<10	<10	<50	20	3056	<50	502	<5	499	50	64	553	35	0.1
	6/11/80	20	<0.3	0.2	<2.1	<0.2	<0.01	<10	10	<50	20	645	<50	388	5	50	<50	360	82	26	0.1
	7/15/80	25	<0.3	0.2	<0.1	<0.2	<0.01	<10	10	<50	20	1635	<50	1078	<5	<50	<50	100	52.9	16	0.13
	7/25/80	30	<0.3	0.2	<0.1	<0.2	<0.01	12	<10	<50	20	694	50	1337	<5	<50	50	148	19	50	<0.13
	7/31/80	52	2.64	0.3	<0.1	0.2	<0.01	14	10	<50	20	365	50	4464	<5	<50	<50	160	14	35	[illegible]
	9/23/80	<10	1.0	<0.2	<0.1	<0.2	<0.01	<10	<10	<50	30	265	<50	155	<5	50	57	20	6	24	0.2
	10/14/80	10	0.7	<0.2	0.2	0.2	<0.01	10	10	<50	118	173	50	<50	<2	50	59	28	[illegible]	[illegible]	<0.1
Crutcho Ck. (Picnic) (400 Ft. N. Bldg. 6600)	5/30/80	25	<0.3	0.6	0.3	0.2	<0.01	10	<10	<50	20	1611	50	239	<5	238	50	72	145	29	[illegible]
	6/11/80	20	0.4	0.4	<0.1	0.2	<0.01	10	<10	<50	20	151	50	342	5	50	50	380	10	25	[illegible]
	7/15/80	20	-	<0.4	<0.1	<0.2	<0.01	<10	10	<50	20	1620	50	1276	<5	50	50				
	7/25/80	88	<0.3	0.4	<0.1	<0.2	<0.01	14	10	<50	20	378	50	1419	<5	<50	50	176	26	18	[illegible]
	7/31/80	65	0.48	0.3	<0.1	<0.2	<0.01	16	<10	<50	20	602	50	1621	5	50	<50	190	5	70	[illegible]
	9/23/80	<10	<0.3	0.2	<0.1	<0.2	<0.01	<10	<10	<50	20	485	50	712	5	50	50	163	30	16	[illegible]
	10/14/80	15	0.7	<0.2	<0.1	<0.2	<0.01	<10	<10	54	17	202	50	196	2	<50	50	80		4	[illegible]

[*] Determined to be Methylene Blue Active Substances (MBAS).

TABLE C.2

HISTORICAL WATER QUALITY DATA
U.S. GEOLOGICAL SURVEY

Station No./Location		Date	Parameter			Remarks
USGS 1	NW Stream, near Air Depot Road at SE 29th	6/7/63	Mn	34	µg/l	Surface Water Sample
USGS 2	West Side Creek at Air Depot Blvd.	6/7/63	Cr	129	µg/l	Surface Water Sample
			Mn	26	µg/l	
			Cd	26	µg/l	
USGS 3	Above Sewage O/F at Air Depot & 44th St.	6/7/63	Pb	45	µg/l	Surface Water Sample
			Mn	400	µg/l	
			V	24	µg/l	
USGS 4	Above sewage O/F, 6/7/63 50 yds West Douglas Blvd.	6/7/63	Cd	2,950	µg/l	Surface Water Sample
			Cr	2,180	µg/l	
			Mn	58	µg/l	
			Ni	129	µg/l	
			V	32	µg/l	
USGS 5	TAFB Gate 7 and SE 29th	6/7/63	Al	620	µg/l	Surface Water Sample
			Cd	46,000	µg/l	
			Cr	31,000	µg/l	
			Fe	540	µg/l	
			Mn	1,400	µg/l	
			Ni	242	µg/l	
			Ag	>500	µg/l	Semi-quantitative
*USGS 6	NE 10th, Between Sooner and Air Depot Blvd.	12/12-14/73	Mn (Total)	780	µg/l	Crutcho Creek Surface Water sample
			Mn (Diss.)	730	µg/l	
			Zn (Total)	320	µg/l	
*USGS 7	E. Reno Ave., 1/2 mile E. of Mid-west	12/12-14/73	Mn (Total)	840	µg/l	Soldier Creek Surface Water Sample
			Mn (Diss.)	840	µg/l	
			Zn (Total)	530	µg/l	

*Note: Sampling station located north of Tinker AFB.

TABLE C.3

OKLAHOMA WATER RESOURCES
BOARD DATA

Station No./Location	Date	Parameter			Remarks
E. Soldier Creek at Douglas Boulevard	7/14/81	Cr	20,650	mg/kg	Sediment Sample
		CN	161	mg/kg	
		Ni	6,900	mg/kg	
		Cd	305	mg/kg	
		Rn	153	mg/kg	
		Zn	295	mg/kg	
Crutcho Creek at Fire Training Area	7/14/81	COD	79,530	mg/l	Soil Sample
		Pb	109	mg/kg	
		O & G	106,200	mg/kg	
		TOC	7377	mg/kg	

Source: Thomas H. Maiello
Oklahoma Water REsources Board 16 November, 1981

TABLE C.4

WATER QUALITY DATA COLLECTED FOR THE Ph.D. DISSERTATION PREPARED BY R. H. FRANK, JR., ENTITLED "TRACE METAL POLLUTION OF THE NORTH CANADIAN RIVER BASIN," 1969, UNIVERSITY OF OKLAHOMA

Station # and Location	Date	Parameters (mg/l)						
		Cd	Cr (tot.)	Cu	Fe	Ni	Zn	Ag
Soldier Creek (at Interstate 40, Station III-B)	8/16/67	0.05	0.76	0.15	0.74	22.0	0.13	0.03
	9/15/67	0.07	0.25	0.18	2.80	0.44	0.28	0.01
	10/13/67	0.41	3.50	0.18	5.00	1.10	0.50	0.03
	11/12/67	0.03	0.35	-	2.10	0.15	0.16	0.03
	11/19/67	0.10	3.20	-	0.44	0.22	0.08	0.01
	12/19/67	0.15	0.36	0.15	0.90	0.66	0.05	0.01
	12/24/67	0.30	0.82	0.23	1.95	1.80	0.16	0.01
	12/31/67	0.15	0.70	-	0.90	2.60	0.10	0.03
	1/29/68	0.05	0.88	0.18	0.74	0.22	0.22	0.03
	2/16/68	1.10	0.71	0.34	2.10	0.66	0.28	0.03
	3/27/68	0.15	3.00	0.4	1.95	0.66	0.22	0.07
	3/29/68	0.41	3.40	0.4	14.00	2.0	0.55	2.15
	4/1/68	2.80	1.40	0.5	1.80	0.54	1.10	0.08
	4/2/68	0.12	1.10	0.4	0.90	0.44	0.28	0.02
	4/3/68	0.15	1.90	0.4	0.60	0.44	0.38	0.01
	4/4/68	0.38	1.50	0.34	0.70	0.90	0.35	0.03
	4/5/68	0.90	1.10	0.34	2.25	0.90	0.35	0.17
	4/6/68	0.05	0.98	-	0.60	0.90	0.13	0.01
	5/8/68	1.30	2.50	0.4	5.00	6.50	0.31	0.03
Crutcho Creek (at Interstate 40 Station III-C	9/5/67	0.25	0.90	0.18	4.00	1.10	0.51	0.01
	9/6/67	0.25	0.58	-	2.70	0.22	0.10	-
	12/10/67	0.30	-	0.15	1.20	0.01	0.05	0.01
	2/20/68	0.08	0.05	0.25	0.15	0.10	0.05	-
	3/29/68	0.23	1.80	0.15	0.60	0.44	1.5	0.01
	4/5/68	0.25	0.05	0.18	0.30	-	0.10	0.01
Industrial Blvd Drainage Ditch to Soldier Creek (at Interstate 40, Station III-D)	4/5/68	2.0	7.2	0.55	3.60	1.80	0.58	0.04
	5/8/68	0.5	1.5	0.25	0.74	0.22	0.45	0.003

APPENDIX D

MASTER LIST OF INDUSTRIAL SHOPS

APPENDIX D

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Directorate of Distribution				
Petroleum Storage	290	X	X	CES* Contractor
LOX Systems	1050			
Fuel Services Section	240			
Woodworking Support Section	1			
Paint Support Section	1	X	X	CES Contractor
Installation & Repair Section	1	X		
Central Processing Unit	506	X		
Receiving & Processing Section	506	X		
Air Freight Section	260	X		
Packing Section	506	X	X	DPDO
Packaging Services Section	1	X		
Cargo Operations	506			
Rail Operations	24	X	X	
Drum Storage	1121			CES Contractor
Hazardous Storage Unit	16	X	X	DPDO and CES Contractor

* CES - Civil Engineering Squadron

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Directorate of Distribution (Con't)				
Directorate of Maintenance				
Aircraft Division				
Cargo Dock Unit	230	X	X	MADE* Contractor
Cargo Structural Unit	240	X	X	MADE Contractor
Cargo Systems Unit	240	X		
Cargo Pre & Post Dock Unit	3105			
Cargo Avionics Unit	3105			
Disassembly & Cleaning Unit	2122	X	X	IWTP** and MADE Contractor
Paint Unit	2280	X	X	IWTP and MADE Contractor
Servicing Unit	2122	X		
Fighter Aircraft Unit	3001			
Fighter Structural Unit	3001	X		
Fighter Systems Unit	3001			
Sheetmetal Backshop Unit	3001	X	X	MADE Contractor
Fighter Avionics Unit	3102	X		
Bomber Docks	2121	X	X	MADE Contractor

* MADE - Office for Plant Management Division

**IWTP - Industrial Waste Treatment Plant

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Aircraft Division (Con't)				
Bomber Docks	2121	X	X	MADE Contractor
Bomber Ramp	2121	X		
Bomber Landing Gear Shop	2121	X		
Bomber Sealant Shop	2122	X		
Bomber Glass & Rubber Shop	2122	X		
Bomber Structural Unit	2121			
Bomber Systems Unit	2121	X		
Bomber Pre & Post Dock Unit	3102	X	X	MADE Contractor
Bomber Avionics Unit	2121			
Material Control Section	3001	X	X	MADE Contractor
Transient Alert Branch	240/238	X	X	IWTP and DPDO
Plant Management Division				
Mechanical Installation Sect.	3001	X	X	IWTP
Installation Sect.	2129	X	X	IWTP and MADE Contractor
Metal Processing Sect.	2101	X		
AGE Contractor	2101	X		IWTP and MADE Contractor
Area A Equipment Sect.	210	X		

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Plant Management Division (Con't)				
Area B Equipment Sect.	2210			
Area C Equipment Sect.	3001	X		
Elec. & Electrical Repair Unit	3001	X		
Numerical & Computer Control Repair Unit	3001	X		
Mechanical Unit	3001	X	X	MADE Contractor
Pipefitter & Refrig. Unit	3001	X		
B3108 Test Equip Unit	3108	X	X	MADE Contractor
Engine Test Equip Unit	3234	X		
Miscellaneous Services Sect.	101			
Transient & Mat'l Processing Sect.	3001	X	X	DPDO
Propulsion Division				
Parts Inspection Unit	3001	X	X	IWTP and MADE Contractor
Parts Processing Unit	3001	X	X	MADE Contractor
Cleaning Subunit	3001	X	X	MADE Contractor
Blasting Subunit	3001	X	X	IWTP and MADE Contractor
Disassembly Unit	3001			

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Propulsion Division (Con't)				
TF30 Rotor Unit	3001	X	X	MADE Contractor
TF30 Assembly Unit	3001	X	X	MADE Contractor
J57 Rotor Unit	3001	X	X	DPDO
J57 Assembly Unit	3001	X	X	DPDO
J75 Assembly Unit	3001	X	X	MADE Contractor
TF41 Assembly Unit	3001	X	X	MADE Contractor
TF33 Assembly Subunit	3001	X	X	DPDO
TF33 Rotor Subunit	3001	X	X	MADE Contractor
TDR* & EACI** Section	3001	X		
Fan Jet Machining Subunit	3001	X	X	DPDO
Jet Machining Subunit	3001	X	X	DPDO
Lapping & Rework Subunit	3001	X	X	MADE Contractor
Heavy Grinding Subunit	3001	X		
Light Grinding Subunit	3001	X	X	DPDO
Hour Glass Case Subunit	3001	X	X	MADE Contractor
Specialized Machining Subunit	3001	X	X	MADE Contractor

* Tear-down Deficiency Report

** Engine Analysis Condition Report

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Propulsion Division (Con't)				
Heavy Case Subunit	3001	X	X	MADE Contractor
Heavy Grinding Subunit	3001	X	X	MADE Contractor
Component Machining Subunit	3001	X	X	MADE Contractor
Rotor Component Mach. Unit	3001	X	X	MADE Contractor
Turbine Blade Unit	3001	X	X	MADE Contractor
Gear Box Unit	3001	X	X	MADE Contractor
Compressor Blade Unit	3001	X		
Chrome Plating Subunit	3001	X	X	IWTP and MADE Contractor
Nickel Plating Subunit	3001	X	X	IWTP and MADE Contractor
Misc. Plating Subunit	3001	X	X	IWTP and MADE Contractor
Solution Maintenance Subunit	3001	X	X	IWTP and MADE Contractor
Heat Treat Subunit	3001	X	X	MADE Contractor
Plasma Spray Subunit	3001	X	X	MADE Contractor
Blasting Subunit	3001	X	X	IWTP and MADE Contractor
Sermetal Subunit	[illegible]01	X	X	MADE Contractor

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Propulsion Division (Con't)				
Coating Subunit	3001	X	X	MADE Contractor
Vane & Shroud Rework Unit	3001	X		
Electric Welding Subunit	3001	X		
Gas Welding Subunit	3001	X		
Resistance Welding Subunit	3001	X		
Material Control Section	3001	X	X	DPDO
Test Section	3234	X	X	IWTP and MADE Contractor
Categorization Unit	3703			
Final Preparation Unit	3703	X	X	IWTP and MADE Contractor
Test Section	3703	x	X	IWTP
Reclamation Unit	2101	X	X	MADE Contractor and DPDO
Stripping Unit	2101	X	X	IWTP and MADE Contractor
Quality Division				
Cargo Quality Section	230			
Bomber Quality Section	2121			
Fighter Quality Section	3001			

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Quality Division (Con't)				
Chemical Laboratory Section	3001	X	X	IWTP AND MADE Contractor
Non-Destructive Insp. Section	3001	X	X	IWTP and MADE Contractor
Metallurgical Section	3001	X	X	MADE Contractor
Material Testing Section	3001			
Jet Engine Quality Section	3001			
Machining and Special Processes Quality Section	3001			
Flight Control and Accys. Quality Section	230			
Engine Accys & Trans. Qlty. Sect.	3001			
Accessories Division				
Area A Precision Measurement (PME) Section	201	X		
Special Measurement Supt. Sect.	3113	X		
Area C PME Section	3113	X		
Cabin Pressure Regulator and Valve Unit	210	X	X	IWTP
Turbine Powered Accys. and Missile Maintenance Unit	210	X	X	MADE Contractor

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Accessories Division (Con't)				
Oxygen & Assoc. Equipment Unit	1055	X	X	MADE Contractor
Air Accys. Testing Unit	210	X	X	MADE Contractor
Electrical Accys. Unit	3001	X	X	IWTP and MADE Contractor
Electro-Mechanical Accys. Unit	3001	X	X	IWTP
Governor, Misc Engine Accys. Overhaul & Test Unit	3001	X	X	MADE Contractor
Fuel Control Overhaul Unit	3001	X	X	MADE Contractor
Accessories Unit	3001	X	X	IWTP
Machine Unit	3001	X	X	MADE Contractor
Accessories Test Unit	3108	X	X	MADE Contractor
Automatic Pilot Unit	230	X	X	IWTP and MADE Contractor
Engine Instrument Unit	230	X		
Flight Control Unit	230	X	X	IWTP and MADE Contractor
Gen. Trans. Overhaul Unit	2210	X	X	IWTP and MADE Contractor
Specialized Transmission Overhaul Unit	2210	X	X	DPDO
Bearing Unit	3001	X	X	MADE Contractor

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Accessories Division (Con't)				
Machine Shop Unit	2210	X	X	IWTP and MADE Contractor
Manufacture Subunit	3001	X	X	MADE Contractor
Tubing & Cable Mfg. Subunit	3001	X	X	DPDO
Tubing & Cable Repair Subunit	3001	X	X	DPDO
Foundry	2101			
Tank & Cooler Unit	3001	X	X	IWTP and MADE Contractor
General Machine Shop Unit	3001	X	X	MADE Contractor
Numerical Control Unit	3001	X	X	DPDO
Woodmill Subunit	2121	X		
Manufacture and Radome Subunit	230	X	X	IWTP and MADE Contractor
Mfg. & Repair Glass Subunit	230	X		
Parachute Subunit	229	X	X	MADE Contractor
Rubber Subunit	229	X	X	MADE Contractor
Tooling/Tool & Die Subunits	3001	X	X	MADE Contractor
Grinding Subunit	3001	X		

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
Accessories Division (Con't)				
Pattern Shop	3001	X	X	DPDO
Gas and Electron Beam Subunit	3001			
General Welding Subunit	3001	X		
Accessories Welding Subunit	3001	X		
Air Accys. Material Control Sect.	230			
ALC Miscellaneous Shops				
Specialized Eng. Branch	3220	X		
Vocational Technical Training Center	675	X	X	MADE Contractor
2953 Combat Logistic Supp. Sqdn.	3001	X	X	MADE Contractor
2854 Air Base Group				
Printing & Duplicating Sect.	1	X	X	IWTP
Small Arms Marksmanship Br.	1023			
Photo Lab.	4026	X	X	Silver recov. then IWTP
Aircrew Life Support Branch	3102	X		
Restaurant Equip. Maintenance	203	X		

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
2854 Air Base Group (Con't)				
Restaurant Vehicle Maint.	769	X		
Bowling Lanes	5703			
Auto Hobby Shop	6002	X	X	CES Con-tractor
Ceramics Hobby Shop	6002			
Wood Hobby Shop	6002			
General Purpose Maintenance	2101	X	X	CES Con-tractor
Special Purpose Vehicle Maintenance	2101	‹	X	CES Con-tractor
Refueling Maintenance	2110	X	X	CES Con-tractor
2854 Civil Engineering Squadron				
Fire Protection Branch	461	X		
Protective Coating Unit	414	X	X	CES Con-tractor
Metal Working Unit	414			
Plumbing Unit	414	X		
Structural Unit	414			
Exterior Electrical Unit	414	X	X	CES Con-tractor
Interior Electrical Unit	414	X	X	CES Con-tractor
Grounds/Pavements Section	773	X		

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
2854 Civil Engineering Squadron (Con't)				
Golf Course Maintenance	6601	X		
Liquid Fuels System Maint.	246	X	X	CES Contractor
Heating Systems Unit	414	X	X	CES Contractor
Refrigeration/Air Conditioning	414	X	X	CES Contractor
Electrical Power Production	414	X	X	CES Contractor
Entomology Unit	773	X	X	CES Contractor
Water/Waste Unit	62516	X	X	CES Contractor
USAF Hospital				
Dental Clinic	5801	X	X	CES Contractor
Clinical Lab	5801	X		
Radiology	5801	X		
Medical Maintenance	5801	X		
Surgery	5801			
Veterinary Services	702	X		
3 Combat Communications Group				
Electrical Power Production	1010	X	X	CES contractor

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
3 Combat Communications Group (Con't)				
Refrig./Air Conditioning Maint.	1010	X		
Navigational Aids Maintenance	900			
Radar Maintenance	7001	X		
Radio Maintenance	7003			
Longhaul Maintenance	7003			
Ground/Air Maintenance	7003			
Wideband Maintenance	904	X		
DSTE Maintenance	7003	X		
Teletype Maintenance	7003	X		
Cryptographic Maintenance	7003			
Inside Plant	7003	X		
Outside Plant	7003			
Vehicle Maintenance	1001	X	X	CES Contractor
6 Weather Squadron				
Vehicle Maintenance	2101	X	X	CES Contractor, oil/water separator and IWTP
507 Tactical Flighter Group				
Flight Line Maintenance	1070	X		

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. NO)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
507 Tactical Flighte. Group (Con't)				
Jet Engine Shop	1070	X	X	CES Contractor
Communications/Navigation Shop	1030	X		
Auto Pilot/Instruments	1030			
Inertial Navigation Shop	1030			
Electronic Countermeasures	1072			
Weapons Control System	1030			
Welding	1030			
Structural Repair	1030			
Machine Shop	1030			
Survival Equipment	1030			
Pneudraulics	1030	X	X	CES Contractor
Mechanical Accys.	1041	X	X	CES Contractor
Electric Shop	1030	X		
Non-Destruct. Inspect.	1030	X		
Powered Aircraft Ground Equip. (AGE)	1041	X	X	CES Contractor
Inspection	1030			
Corrosion Control	1030	X	X	CES Contractor

MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
507 Tactical Flighter Group (Con't)				
Fuel System Repair	1030	X	X	CES Contractor
Repair & Reclamation	1037			
Egress	1030	X		
Loading/LSC		X		
Armament/Gun Shop	1030	X	X	CES Contractor
Life Support	1048	X		
Munitions Storage	1030	X		
552 Aircraft Warning and Control Wing				
Acft. Gen. Sqdn. (AGS) E3A Aircraft Maint. Unit (AMU)	230	X	X	CES Contractor
AGS-C135 AMU	230	X	X	CES Contractor
Component Repair Sqdn. (CRS)-Comm. Shop	230			
CRS-Nav/Instrum Shop	230			
CRS-Computer Shop	230			
CRS-Radar Shop	230	X		
CRS-Corrosion Control	289	X	X	CES Contractor

MASTER LISTS
INDUSTRIAL SHOPS

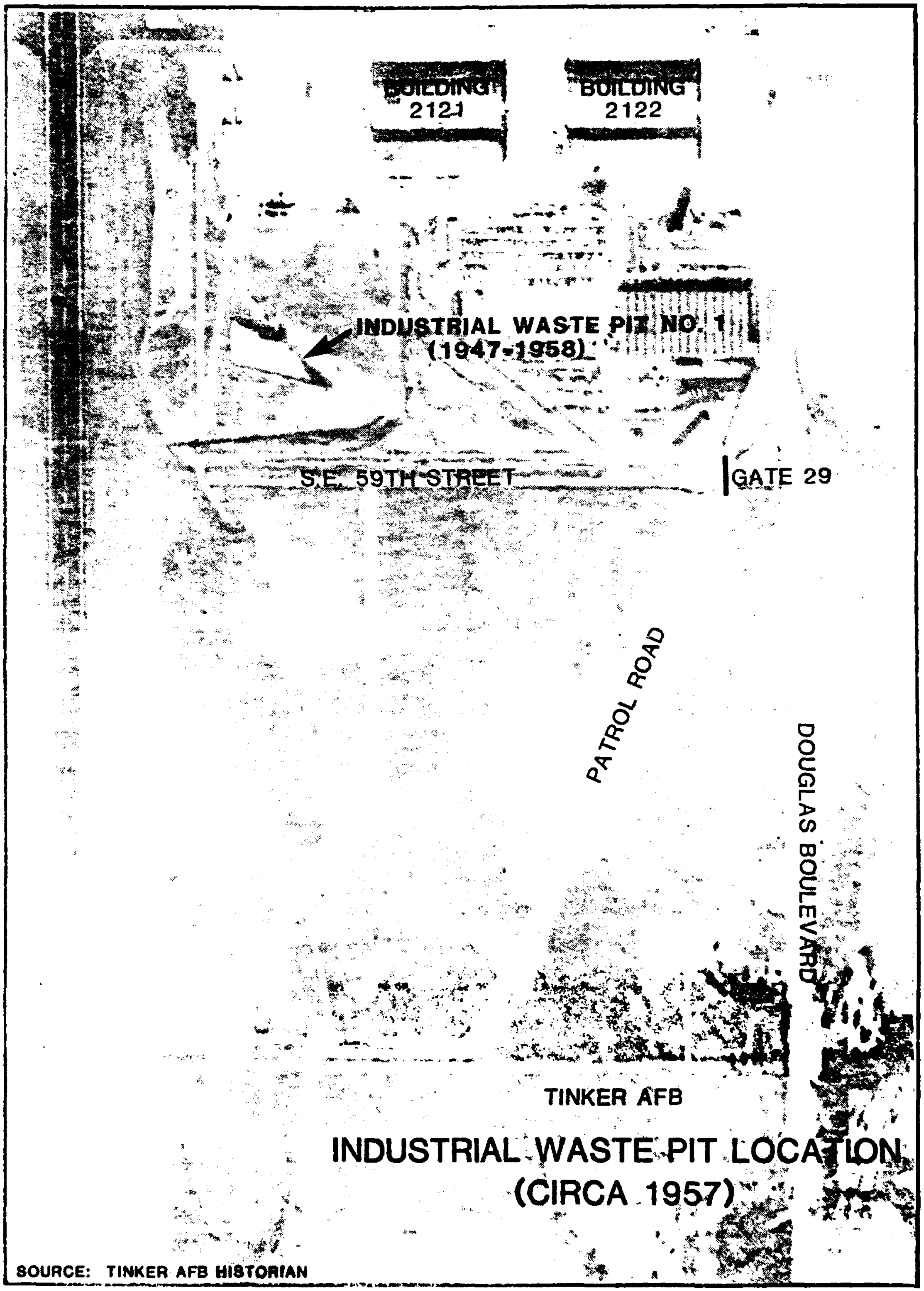
Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
552 Aircraft Warning and Control Wing (Con't)				
CRS-Fuel Cell Section	230	X	X	CES Con-tractor
CRS-Maintenance Inspection	230	X	X	CES Con-tractor
CRS-Repair & Reclamation	230			
CRS-Flight Simulator	283	X		
CRS-AGE Branch	228	X	X	CES Con-tractor
CRS-Electric Shop	230	X		
CRS-Environ. Control Systems Shop	230	X	X	CES Con-tractor
CRS-Hydraulic Shop	230	X	X	CES Con-tractor
CRS-Jet Engine Shop	228	X	X	CES Con-tractor
CRS-Sheet Metal/Machine Shop	230	X		
CRS-Welding Shop	228			
Wing Life Support	221			
1985 Communications Squadron				
Power Production	3001	X	X	DPDO
Navigational Aids Maintenance	18			

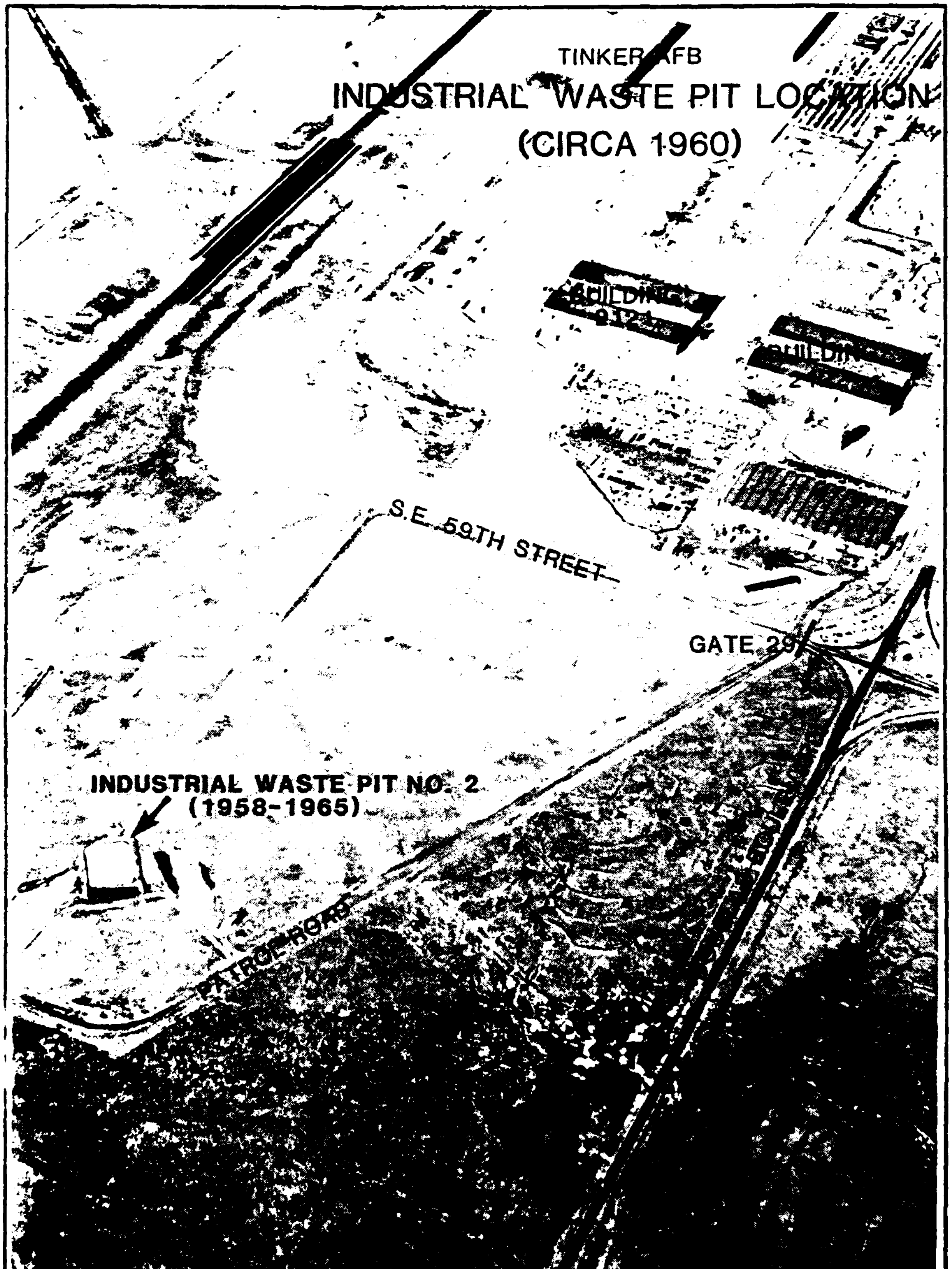
MASTER LISTS
INDUSTRIAL SHOPS

Name	Present Location (Bldg. No)	Handles Hazardous Materials	Generates Hazardous Wastes	Past On-site T.S.D
1985 Communications Squadron (Con't)				
Radar Maintenance	249			
Weather Maintenance	219			
Radio Maintenance	18			
TV Maintenance	18			
Centralized Repair Activity	2101			
Teletype Maintenance	18			
Crypto Maintenance	3001			
Defense Property Disposal Office	3767	X	X	DPDO Contractor Disposal

APPENDIX E

PHOTOGRAPHS

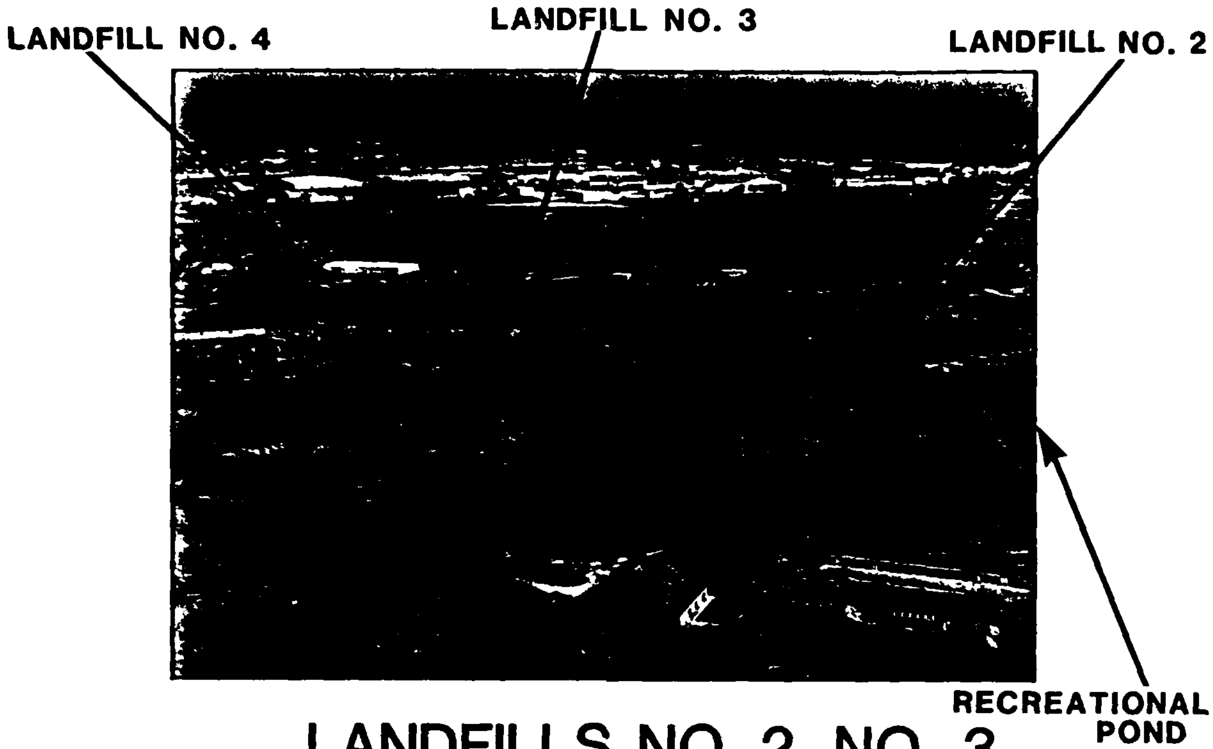

BUILDING 2121
BUILDING 2122
INDUSTRIAL WASTE PIT NO. 1 (1947-1958)
S.E. 59TH STREET
GATE 29
PATROL ROAD
DOUGLAS BOULEVARD
TINKER AFB
INDUSTRIAL WASTE PIT LOCATION (CIRCA 1957)
SOURCE: TINKER AFB HISTORIAN



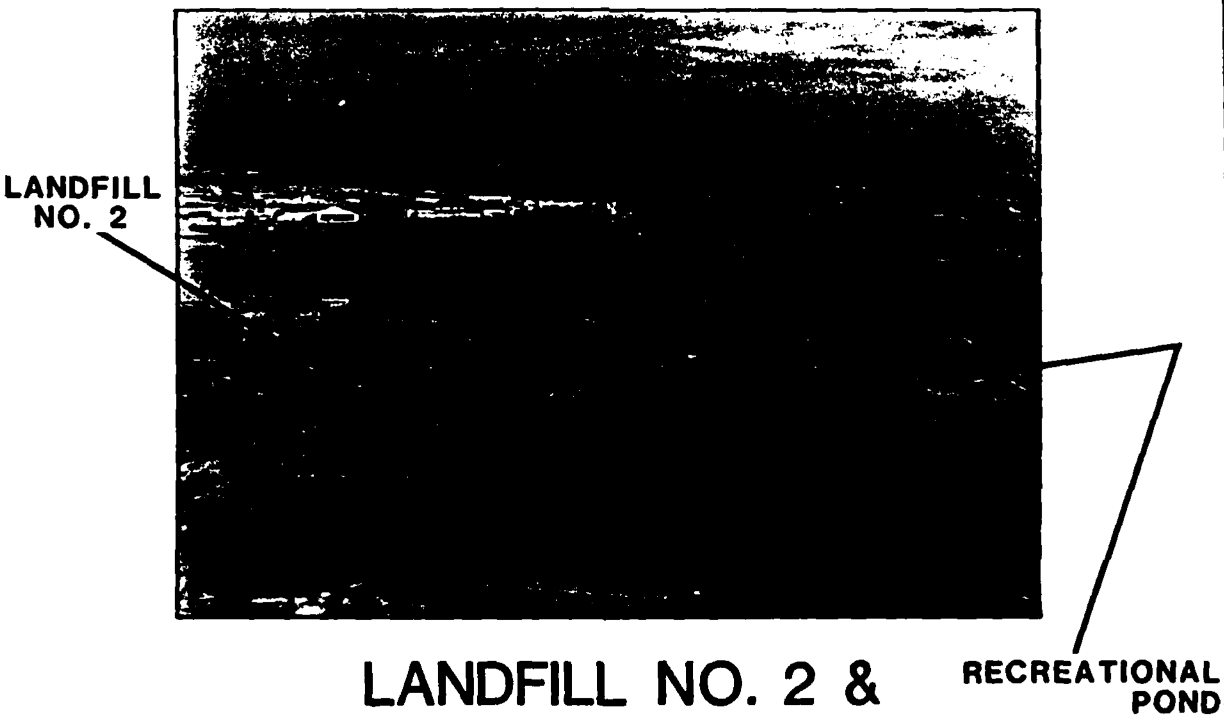
TINKER AFB
INDUSTRIAL WASTE PIT LOCATION
(CIRCA 1960)
BUILDING
BUILDING
S.E. 59TH STREET
GATE 29
INDUSTRIAL WASTE PIT NO. 2
(1958-1965)
PATROL ROAD

LANDFILL NO. 1

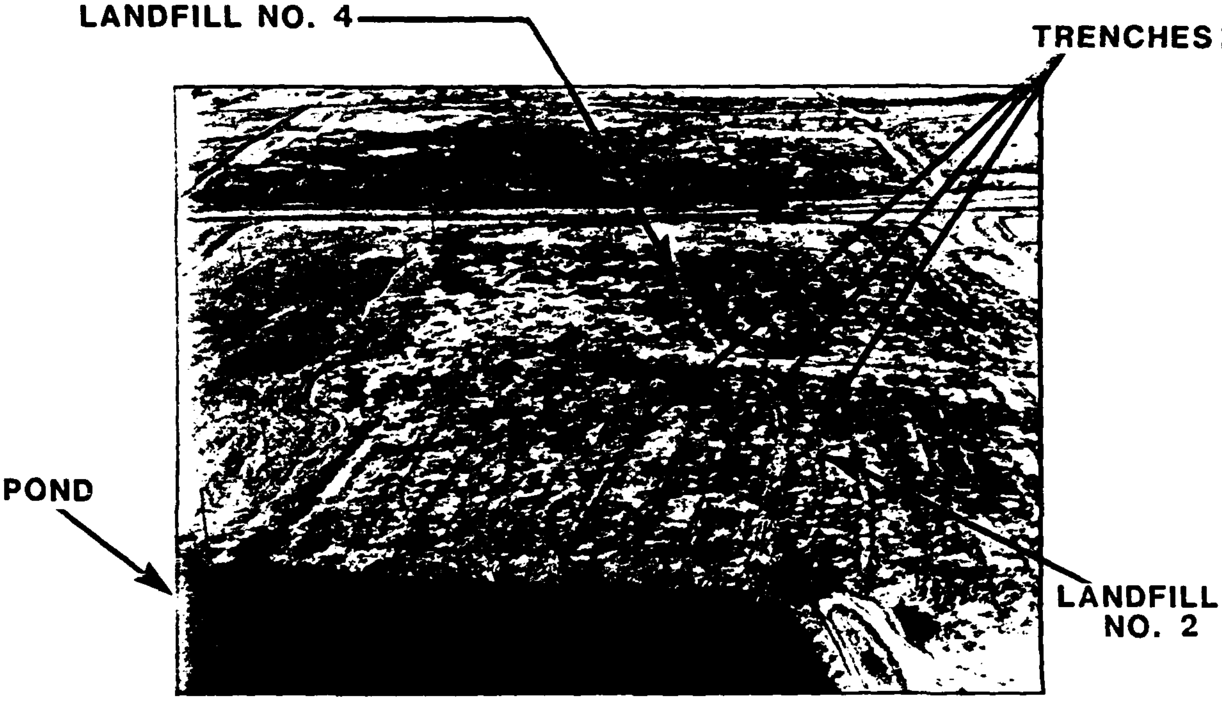
LANDFILL NO. 1



LANDFILLS NO. 2, NO. 3 & NO.4



LANDFILL NO. 2 & RECREATIONAL POND



LANDFILLS NO. 2 & NO. 4

POND at LANDFILL NO. 2

LANDFILL AREA

LANDFILL NO. 5

AREA D

LANDFILL AREA

LANDFILL NO. 6

APPENDIX F

REFERENCES

APPENDIX F

REFERENCES

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APPENDIX G

HAZARD EVALUATION METHODOLOGY

APPENDIX G

USAF INSTALLATION RESTORATION PROGRAM

HAZARD ASSESSMENT RATING METHODOLOGY

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

> "develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from USAF Occupational Environmental Health Laboratory (OEHL), Air Force Engineering Services Center (AFESC), Engineering-Science (ES) and CH_2M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering Science, and CH_2M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data readily obtained during the Record Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, potential pathways for waste contaminant migration, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste managment practices category factor to the sum of the scores for the other three categories.

FIGURE 1

HAZARDOUS ASSESSMENT RATING METHODOLOGY FLOW CHART

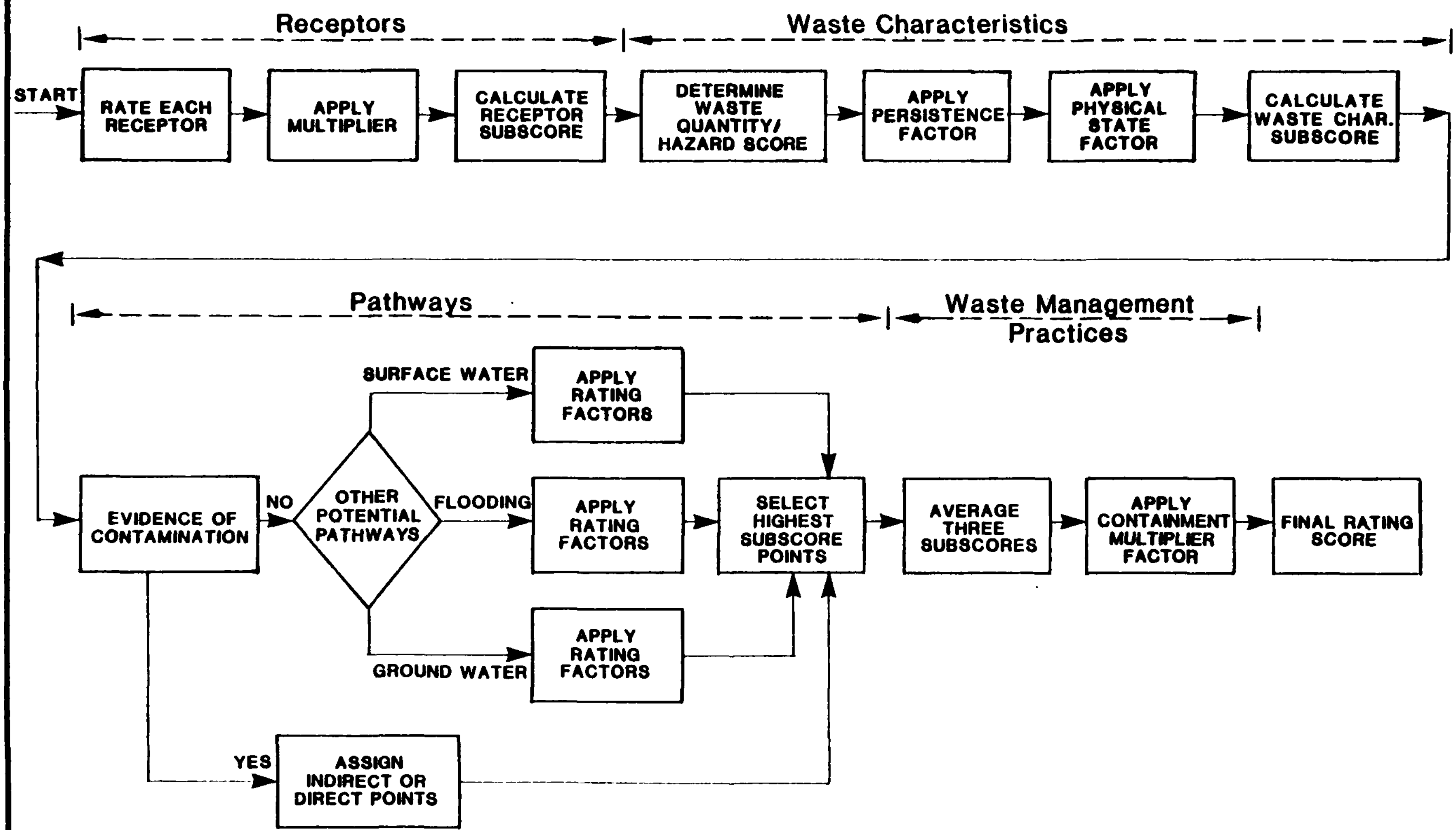

FIGURE 2

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE ______________________________

LOCATION ______________________________

DATE OF OPERATION OR OCCURRENCE ______________________________

OWNER/OPERATOR ______________________________

COMMENTS/DESCRIPTION ______________________________

SITE RATED BY ______________________________

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		6		
		Subtotals	______	______

Receptors subscore (100 X factor score subtotal/maximum score subtotal) ______

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) ______
2. Confidence level (C = confirmed, S = suspected) ______
3. Hazard rating (H = high, M = medium, L = low) ______

Factor Subscore A (from 20 to 100 based on factor score matrix) ______

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

______ X ______ = ______

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

______ X ______ = ______

FIGURE 2 (Continued)

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore ______

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		
		Subtotals	______	______

Subscore (100 X factor score subtotal/maximum score subtotal) ______

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding		1		

Subscore (100 x factor score/3) ______

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water		8		
Net precipitation		6		
Soil permeability		8		
Subsurface flows		8		
Direct access to ground water		8		
		Subtotals	______	______

Subscore (100 x factor score subtotal/maximum score subtotal) ______

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore ______

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors ______
Waste Characteristics ______
Pathways ______

Total ______ divided by 3 = ______
Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

______ X ______ = ______

TABLE 1

HAZARDOUS ASSESSMENT RATING METHODOLOGY GUIDELINES

I. RECEPTORS CATEGORY

Rating Factors	Rating Scale Levels 0	1	2	3	Multiplier
A. Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land Use/Zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or industrial	Residential	6
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	3
E. Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination.	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands.	10
F. Water quality/use designation of nearest surface water body	Agricultural or industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies	6
G. Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, municipal water available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1, 000	6

TABLE 1 (Continued)

HAZARDOUS ASSESSMENT RATING METHODOLOGY GUIDELINES (Cont'd)

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

S = Small quantity (<5 tons or 20 drums of liquid)
M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
L = Large quantity (>20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- o Verbal reports from interviewer (at least 2) or written information from the records.
- o Knowledge of types and quantities of wastes generated by shops and other areas on base.
- o Based on the above, a determination of the types and *quantities of waste disposed of at the site.*

S = Suspected confidence level

- o No verbal reports or conflicting verbal *reports and no written information from* the records.
- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site.

A-3 Hazard Rating

Hazard Category	Rating Scale Levels 0	1	2	3
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2	Sax's Level 3
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F	Flash point less than 80°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels	Over 5 times background levels

Use the *highest individual rating based on toxicity, ignitability and radioactivity and* determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

TABLE 1 (Continued)

HAZARDOUS ASSESSMENT RATING METHODOLOGY GUIDELINES (Cont'd)

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	M
	M	C	H
70	L	S	H
60	S	C	H
	M	C	M
50	L	S	M
	L	C	L
	M	S	H
	S	C	M
40	S	S	H
	M	S	M
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	M
20	S	S	L

Notes:
For a site with more than one hazardous waste, the waste quantities may be added using the following rules:
Confidence Level
- o Confirmed confidence levels (C) can be added
- o Suspected confidence levels (S) can be added
- o Confirmed confidence levels cannot be added with suspected confidence levels

Waste Hazard Rating
- o Wastes with the same hazard rating can be added
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCM + SCH = LCM if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCM designation (60 points). By adding the quantities of each waste, the designation may change to LCM (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Persistence Criteria	Multiply Point Rating From Part A by the Following
Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Physical State	Multiply Point Total From Parts A and B by the Following
Liquid	1.0
Sludge	0.75
Solid	0.50

TABLE 1 (Continued)

HAZARDOUS ASSESSMENT RATING METHODOLOGY GUIDELINES (Cont'd)

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 *POTENTIAL FOR SURFACE WATER CONTAMINATION*

Rating Factor	Rating Scale Levels: 0	1	2	3	Multiplier
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet	8
Net precipitation	Less than -10 in.	-10 to + 5 in.	+5 to +20 in.	Greater than +20 in.	6
Surface erosion	None	Slight	Moderate	Severe	8
Surface permeability	0% to 15% clay ($>10^{-2}$ cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	Greater than 50% clay ($<10^{-6}$ cm/sec)	6
Rainfall intensity based on 1 year 24-hr rainfall	<1.0 inch	1.0-2.0 inches	2.1-3.0 inches	>3.0 inches	8
B-2 POTENTIAL FOR FLOODING					
Floodplain	Beyond 100-year floodplain	In 25-year floodplain	In 10-year floodplain	Floods annually	1
B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION					
Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	6
Soil permeability	Greater than 50% clay ($>10^{-6}$ cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	0% to 15% clay ($<10^{-2}$ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	8
Direct access to ground water (through faults, fractures, faulty well casings, subsidence fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	8

TABLE 1 (Continued)

HAZARDOUS ASSESSMENT RATING METHODOLOGY GUIDELINES (Cont'd)

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. WASTE MANAGEMENT PRACTICES FACTOR

The following multipliers are then applied to the total risk points (from A):

Waste Management Practice	Multiplier
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Fire Proection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III-B-3, then leave blank for calculation of factor score and maximum possible score.

APPENDIX H

SITE RATING FORMS

SITE RATING FORMS

TABLE OF CONTENTS

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Landfill No. 4

LOCATION South of Landfill Road and east of Air Depot Blvd

DATE OF OPERATION OR OCCURRENCE 1961 to 1968

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E. J. Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	103	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 57

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) L
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 70

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

70 x 1.0 = 70

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

70 x 0.75 = 53

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 100

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		
Subtotals				

Subscore (100 X factor score subtotal/maximum score subtotal) N/A

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding		1		

Subscore (100 x factor score/3) N/A

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water		8		
Net precipitation		6		
Soil permeability		8		
Subsurface flows		8		
Direct access to ground water		8		
Subtotals				

Subscore (100 x factor score subtotal/maximum score subtotal) N/A

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 100

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	57
Waste Characteristics	53
Pathways	100
Total 210 divided by 3 =	70 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

70 x 1.0 = $\boxed{70}$

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Industrial Waste Pit No. 2
LOCATION On hill south of 59th Street overlooking Patrol Road
DATE OF OPERATION OR OCCURRENCE 1958 to 1965
OWNER/OPERATOR Tinker AFB
COMMENTS/DESCRIPTION
SITE RATED BY E J Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	103	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 57

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) L
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

100 x 1.0 = 100

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

100 x 1.0 = 100

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			46	108

Subscore (100 X factor score subtotal/maximum score subtotal) 46

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	0

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 46

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	57
Waste Characteristics	100
Pathways	46

Total 203 divided by 3 = 68 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

68 x 1.0 = 68

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Landfill No. 2

LOCATION South of Landfill Road and west of Reserve Road

DATE OF OPERATION OR OCCURRENCE 1945 to 1952

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E J Edwards

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	101	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 56

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

40 x 1.0 = 40

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

40 x 1.0 = 40

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	62	108

Subscore (100 X factor score subtotal/maximum score subtotal) 57

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	3	1	3	3

Subscore (100 x factor score/3) 100

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 100

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	56
Waste Characteristics	40
Pathways	100

Total 196 divided by 3 = 65 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

65 x 1.0 = $\boxed{65}$

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Industrial Waste Pit No. 1

LOCATION South of Bldg. 2121

DATE OF OPERATION OR OCCURRENCE 1947 to 1958

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E J Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) L
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

100 x 1.0 = 100

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

100 x 1.0 = 100

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	30	108

Subscore (100 X factor score subtotal/maximum score subtotal) 28

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 28

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	100
Pathways	28

Total 182 divided by 3 = 61 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

61 x 1.0 = 61

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Landfill No. 3

LOCATION North of Landfill Road, south of West Crutcho Creek

DATE OF OPERATION OR OCCURRENCE 1952 to 1961

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E J Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

60 x 1.0 = 60

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

60 x 1.0 = 60

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	3	8	24	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			70	108

Subscore (100 X factor score subtotal/maximum score subtotal) 65

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 65

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	60
Pathways	65

Total 179 divided by 3 = 60 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

60 x 1.0 = 60

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE RWDS 1030 W

LOCATION 1700 feet west and 530 feet north of Building 1030

DATE OF OPERATION OR OCCURRENCE

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E J Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	101	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 56

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) L

Factor Subscore A (from 20 to 100 based on factor score matrix) 20

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

20 x 1.0 = 20

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

20 x 1.0 = 20

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	46	108

Subscore (100 X factor score subtotal/maximum score subtotal) 43

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding	3	1	3	3

Subscore (100 x factor score/3) 100

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	40	114

Subscore (100 x factor score subtotal/maximum score subtotal) 35

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 100

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 56
Waste Characteristics 20
Pathways 100

Total 176 divided by 3 = 59
Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

59 x 1.0 = 59

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Landfill No. 6

LOCATION Adjacent to Area D

DATE OF OPERATION OR OCCURRENCE

OWNER/OPERATOR Tinker operated site leased from Oklahoma City

COMMENTS/DESCRIPTION

SITE RATED BY E I Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	107	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 59

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) M
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

60 x 1.0 = 60

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

60 x 0.75 = 45

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	3	8	24	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			70	108

Subscore (100 X factor score subtotal/maximum score subtotal) 65

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 65

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	59
Waste Characteristics	45
Pathways	65
Total 169 divided by 3 =	56 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

56 x 1.0 = 56

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Fire Training Area No. 1

LOCATION West of Air Depot Blvd. and north of West Crutcho Creek

DATE OF OPERATION OR OCCURRENCE 1950 to 1962

OWNER/OPERATOR Fire Department

COMMENTS/DESCRIPTION

SITE RATED BY E J Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) L
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 70

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

70 x 1.0 = 70

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

70 x 1.0 = 70

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	46	108

Subscore (100 X factor score subtotal/maximum score subtotal) 42

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	70
Pathways	42

Total 166 divided by 3 = 55 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

55 x 1.0 = 55

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Landfill No. 5

LOCATION North of Patrol Road and east of Tower Road

DATE OF OPERATION OR OCCURRENCE 1968 to 1970

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E J Edwards

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	103	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 57

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

40 x 1.0 = 40

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

40 x 1.0 = 40

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	62	108

Subscore (100 X factor score subtotal/maximum score subtotal) 57

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 57

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	57
Waste Characteristics	40
Pathways	57

Total 154 divided by 3 = 51 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

51 x 1.0 = 51

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE RWDS 1022E

LOCATION Northwest of and adjacent to Landfill No. 3

DATE OF OPERATION OR OCCURRENCE

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E/ Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	[illegible]
B. Distance to nearest well	[illegible]	10	30	[illegible]
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	[illegible]	6	12	18
E. Critical environments within 1 mile radius of site	[illegible]	10	0	[illegible]
F. Water quality of nearest surface water body	0	6	[illegible]	18
G. Ground water use of uppermost aquifer	[illegible]	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	[illegible]	6	[illegible]	18
I. Population served by ground-water supply within 3 miles of site	[illegible]	6	18	18
		Subtotals	97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) M

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

50 x 1.0 = 50

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

50 x 1.0 = 50

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	46	108

Subscore (100 X factor score subtotal/maximum score subtotal) 42

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	50
Pathways	42

Total 146 divided by 3 = 49 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

49 x 1.0 = 49

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Fire Training Area No. 2

LOCATION Approximately 700 feet west of the Control Tower

DATE OF OPERATION OR OCCURRENCE 1962 to 1966

OWNER/OPERATOR Fire Department

COMMENTS/DESCRIPTION Temporary fireman training area, infrequently used.

SITE RATED BY E J Edwards

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

40 x 0.9 = 36

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

36 x 1.0 = 36

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	1	8	8	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			54	108

Subscore (100 X factor score subtotal/maximum score subtotal) 50

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 50

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	36
Pathways	50
Total 140 divided by 3 =	47 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

47 x 1.0 = 47

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE Landfill No. 1

LOCATION East of Air Depot Blvd; South of West Crutcho Creek

DATE OF OPERATION OR OCCURRENCE 1942 to 1945

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY [signature]

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

40 x 1.0 = 40

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

40 x 1.0 = 40

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	46	108

Subscore (100 X factor score subtotal/maximum score subtotal) 42

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	40
Pathways	42
Total 136 divided by 3 =	45 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

45 x 1.0 = $\boxed{45}$

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE RWDS 62598

LOCATION North of West Crutcho Creek and Lnadfill No. 3

DATE OF OPERATION OR OCCURRENCE

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E J Schneider

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	97	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 54

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) S
3. Hazard rating (H = high, M = medium, L = low) M

Factor Subscore A (from 20 to 100 based on factor score matrix) 30

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

30 x 1.0 = 30

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

30 x 0.5 = 15

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	46	108

Subscore (100 X factor score subtotal/maximum score subtotal) 42

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
		Subtotals	32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	54
Waste Characteristics	15
Pathways	42

Total 111 divided by 3 = 37 Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

37 x 1.0 = 37

HAZARDOUS ASSESSMENT RATING FORM

NAME OF SITE RWDS 201S

LOCATION South of Bldg. 201 next to conveyor

DATE OF OPERATION OR OCCURRENCE

OWNER/OPERATOR Tinker AFB

COMMENTS/DESCRIPTION

SITE RATED BY E.J. Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	3	4	12	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	3	9	27	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
		Subtotals	95	180

Receptors subscore (100 X factor score subtotal/maximum score subtotal) 53

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) M

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

50 x 1.0 = 50

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

50 x 0.5 = 25

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore N/A

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			30	108

Subscore (100 X factor score subtotal/maximum score subtotal) 28

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water	1	8	8	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	0	8	0	24
Subtotals			32	114

Subscore (100 x factor score subtotal/maximum score subtotal) 28

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 28

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 53
Waste Characteristics 25
Pathways 28

Total 106 divided by 3 = 35
Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

35 x 1.0 = $\boxed{35}$

APPENDIX I

GLOSSARY

APPENDIX I

GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

ACFT MAINT: Aircraft Maintenance

AF: Air Force

AFB: Air Force Base

AFLC: Air Force Logistics Command

AFR: Air Force Regulation

AFSC: Air Force Systems Command

AG: Adjutant General

Ag: Chemical symbol for silver

AGE: Aircraft Ground Equipment

Al: Chemical symbol for aluminum

ARTESIAN: Ground water contained under hydrostatic pressure

AQUICLUDE: Poorly permeable formation that impedes ground-water movement and does not yield water to a well or spring

AQUIFER: A geologic formation, group of formations, or part of a formation that is capable of yeilding water to a well or spring

AQUITARD: A soils formation which impedes groundwater flow

AVGAS: Aviation Gasoline

AWACS: Airborne Warning and Control System

AWADS: Airborne Warning and Detection System

Ba: Chemical symbol for barium

BEE: Bioenvironmental Engineering

BIOACCUMULATE: Tendency of elements or compounds to accumulate or build up in the tissues of living organisms when they are exposed to these elements in their environments, e.g., heavy metals

Cd: Chemical symbol for cadmium

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act

CES: Civil Engineering Squadron

CIRCA: About; used to indicate an approximate date

CLOSURE: The completion of a set of rigidly defined functions for a hazardous waste facility no longer in operation

CN: Chemical symbol for cyanide

COD: Chemical Oxygen Demand, a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water

COE: Corps of Engineers

CONFINED AQUIFER: An aquifer bounded above and below by impermeable beds or by beds of distinctly lower permeability than that of the aquifer itself

CONTAMINATION: The degradation of natural water quality to the extent that its usefulness is impaired; there is no implication of any specific limits since the degree of permissible contamination depends upon the intended end use or uses of the water

Cr: Chemical symbol for chromium

Cu: Chemical symbol for copper

DASC: Direct Air Support Center

DET: Detachment

DISPOSAL FACILITY: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which waste will remain after closure

DISPOSAL OF HAZARDOUS WASTE: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground water

DOD: Department of Defense

DOWNGRADIENT: In the direction of decreasing hydraulic static head; the direction in which ground water flows

DPDO: Defense Property Disposal Office, previously included R&M, Redistribution and Marketing.

DUMP: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics; dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers

EOD: Explosive Ordnance Disposal

ECM: Electronic Countermeasures

EFFLUENT: A liquid waste discharge from a manufacturing or treatment process, in its natural state, or partially or completely treated, that discharges into the environment

EPA: U.S. Environmental Protection Agency

EROSION: The wearing away of land surface by wind or water

EPHEMERAL AQUIFER: An aquifer usually near the surface which is only temporary in nature.

FAA: Federal Aviation Administration

FACILITY: Any land and appurtenances thereon and thereto used for the treatment, storage and/or disposal of hazardous wastes

Fe: Chemical symbol for iron

FLOOD PLAIN: The lowland and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to a one percent or greater chance of flooding in any given year

FLOW PATH: The direction or movement of ground water and any contaminants that may be contained therein, as governed principally by the hydraulic gradient

FPT: Fire Protection Training

FTA: Fire Training Area

GM: General Motors Corp

GROUND WATER: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure

GROUND WATER RESERVOIR: The earth materials and the intervening open spaces that contain ground water

HALF-LIFE: The time required for half the atoms present in radioactive substance to disintegrate

HARDFILL: Disposal sites receiving construction debris, wood, miscellaneous spoil material

HARM: Hazardous Assessment Rating Methodology

HAZARDOUS WASTE: A solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed

HAZARDOUS WASTE GENERATION: The act or process of producing a hazardous waste

HEAVY METALS: Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but which become toxic at higher concentrations

Hg: Chemical symbol for mercury

HQ: Headquarters

HWMF: Hazardous Waste Management Facility

INCOMPATIBLE WASTE: A waste unsuitable for commingling with another waste or material because the commingling might result in generation of extreme heat or pressure, explosion or violent reaction, fire, formation of substances which are shock sensitive, friction sensitive, or otherwise have the potential for reacting violently, formation of toxic dusts, mists, fumes, and gases, volatilization of ignitable or toxic chemicals due to heat generation in such a manner that the likelihood of contamination of ground water or escape of the substance into the environment is increased, any other reaction which might result in not meeting the Air, Human Health, and Environmental Standard

INFILTRATION: The flow of liquid through pores or small openings

IRP: Installation Restoration Program

JP-4: Jet Fuel

LEACHATE: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water

LEACHING: The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water

LINER: A continous layer of natural or man-made materials beneath or on the sides of a surface impoundmnet, landfill, or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents or leachate

LOX: Liquid Oxygen

LYSIMETERS: A vacuum operated sampling device used for extracting pore water samples at various depths within the unsaturated zone

MAC: Military Airlift Command

MAS: Military Air Service

MGD: million gallons per day

MOA: Military Operating Area

Mn: Chemical symbol for manganese

MONITORING WELL: A well used to measure ground-water levels and to obtain samples

Mr/hr: millirem/hour; a measure of radioactivity

MSL: Mean Sea Level

Ni: Chemical symbol for nickel

OEHL: Occupational and Environmental Health Laboratory

ORGANIC: Being, containing or relating to carbon compounds, especially in which hydrogen is attached to carbon

O&G: Symbols for oil and grease

OT&E: Operations, Training and Evaluation

Pb: Chemical symbol for lead

PCP: Polychlorinated Biphenyls are highly toxic to aquatic life; they persist in the environment for long period and are biologically accumulative

PERCOLATION: Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil

Permeability: The rate at which fluids may move through a solid, porous medium.

PD-680: Cleaning solvent, safety solvent, Stoddard's solvent

pH: Negative logarithm of hydrogen ion concentration, measurement of acids and bases

PL: Public Law

POL: Petroleum, Oils and Lubricants

POLLUTANT: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose

RCRA: Resource Conservation and Recovery Act

RECHARGE AREA: An area in which water is absorbed that eventually reaches the zone of saturation in one or more aquifers

RECHARGE: The addition of water to the ground-water system by natural or artificial processes

RECON: Reconnaissance

RWDS: Radioactive Waste Disposal Site

SANITARY LANDFILL: A land disposal site using an engineered method of disposing solid wastes on land in a way that minimizes enviromental hazards

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water

SERMETAL: A water based paint coating used on engine parts

SLUDGE: The solid residue resulting from a manufacturing or wastewater treatment process which also produces a liquid stream

SOLID WASTE: Any garbage, refuse, or sludge from a waste treatment plant, water suply treatment, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities, but does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923)

SPILL: Any unplanned release or discharge of a hazardous waste onto or into the air, land, or water

STORAGE OF HAZARDOUS WASTE: Containment, either on a temporary basis or for a longer period, in such a manner as not to constitute disposal of such hazardous waste

TAC: Tactical Air Command

TAFB: Tinker Air Force Base

TOXICITY: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism

TRANSMISSIVITY: The rate at which water is transmitted through a unit width under a unit hydraulic gradient

TREATMENT OF HAZARDOUS WASTE: Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste nonhazardous

TS: Training site

UPGRADIENT: In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of groundwater

USAF: United States Air Force

V: Chemical symbol for vanadium

WATER TABLE: Surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere

Zn: Chemical symbol for zinc